8

Options for Meeting Future Water Needs in Interior Regions of California

This chapter covers the interior regions of the State: the Sacramento River, San Joaquin River, and Tulare Lake Hydrologic Regions (Figure 8-1). These regions constitute the Central Valley, which makes up about 38 percent of the State's land area and almost 80 percent of the State's irrigated acres.

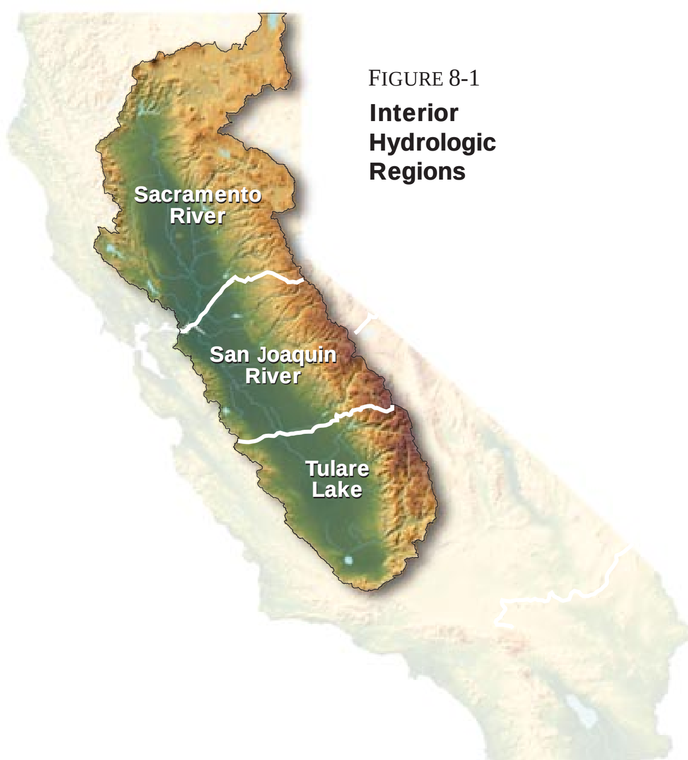


FIGURE 8-1
Interior Hydrologic Regions

The SWP's California Aqueduct.

FIGURE 8-2

Sacramento River Hydrologic Region

Sacramento River Hydrologic Region

. . .

Description of the Area

The Sacramento River Region, the drainage area of the Sacramento River and its tributaries, extends 300 miles from the Oregon border south to Collinsville in the Delta (Figure 8-2). The crest of the Sierra Nevada forms the eastern border of the Sacramento River Region, while the western side is defined by the crest of the Coast Range. The southern portion includes the American River watershed and the northern Delta. The Sacramento River Region includes all or large portions of Modoc, Siskiyou, Lassen, Shasta, Tehama, Glenn, Plumas, Butte, Colusa, Sutter, Yuba, Sierra, Nevada, Placer, Sacramento El Dorado, Yolo, Solano, Lake, and Napa Counties. Small areas of Amador and Alpine Counties are also within the Sacramento River Region. The State's largest river, the Sacramento, flows the length of the valley before entering the Delta. The Sacramento Valley is comprised of eight planning subareas, all of which are hydrologically connected by the Sacramento River.

The region is defined by two distinct features—the foothill and mountain areas of the Sierra Nevada, Cascade, and Coast Ranges, and the valley floor. Mountain elevations range from 5,000 feet along the coast to more than 10,000 feet in the Sierra Nevada. The elevation of the valley floor gradually decreases from 500 feet in the Redding area to just below sea level in the Delta.

Precipitation in the region varies substantially depending on location and elevation. In the foothill and higher mountain areas, precipitation ranges from 40 to more than 80 inches annually. The valley receives less rainfall, with average annual rainfall for Redding and Sacramento being 35 inches and 18 inches, respectively. The mountain areas have cold, wet winters with snow contributing runoff for summer water supply. The valley has mild winters and dry, hot summers.

Base year and future population and crop acreage for the region are provided in Table 8-1. Most of the region's population growth is expected to occur in the southern part of the region in Sacramento, Placer, El Dorado, Sutter, Yolo, and Solano Counties. The Sacramento metropolitan area and surrounding communities are expected to experience significant population growth, as is the Yuba City-Marysville area in Sutter and Yuba Counties. The region includes extensive irrigated agricultural acreage. Rice, irrigated pasture, alfalfa, grain, fruits, nuts, and tomatoes account for about 80 percent of the irrigated crop acreage. Irrigated acreage in the region is expected to change little during the planning period.

Water Demands and Supplies

Water shortages are expected to occur under average and drought conditions, as shown in Table 8-2. The 1995-level average year shortage reflects that groundwater overdraft is not treated as a source of supply. Most of the drought year water shortage is

TABLE 8-1
Population and Crop Acreage

	Population (thousands)	*Irrigated Crop Acreage (thousands of acres)*
1995	2,372	2,139
2020	3,813	2,150

The 3.5 maf Lake Oroville is the largest of the SWP's storage facilities.

associated with agricultural water use, primarily on the valley floor area north of Sacramento.

Excluding supplies dedicated to environmental purposes, surface water accounts for about 70 percent of the region's average year water supply. Groundwater provides the remaining supply. During drought years, additional groundwater is pumped to compensate for reduced surface water supplies. The region has 43 major reservoirs, with a combined storage capacity of almost 16 maf. About half of this surface capacity is contained in the CVP's Shasta Lake and the SWP's Lake Oroville.

CVP Water Supply

Most of the water delivered by CVP facilities in the Sacramento River Region is for agricultural use. Sacramento and Redding receive part of their water supply from CVP facilities.

The Tehama-Colusa and Corning Canals, supplied from Red Bluff Diversion Dam on the Sacramento River, deliver CVP water to agricultural users and to wildlife refuges. The Tehama-Colusa Canal extends 110 miles south of RBDD, terminating south of Dunnigan in Yolo County. The Corning Canal extends 25 miles south of RBDD, terminating near Corning. Together, the canals serve about 160,000 acres of land in Tehama, Glenn, Colusa, and Yolo Counties. CVP contractors and water rights settlement users also make direct diversions from the Sacramento River. Some of the larger water agencies receiving CVP supplies are listed in Table 8-3. The supplies shown include, where applicable, both project water and water rights settlement (base supply) water.

Releases from Folsom Reservoir on the American River serve Delta and CVP export needs, as well as providing supplies to agencies in the Sacramento metropolitan area. The City of Sacramento is the largest water rights contractor on the American River, with a contract for almost 300 taf/yr. Placer County Water Agency, one of the largest American River project water contractors, also holds a water rights settlement contract for 120 taf/yr. EBMUD holds the largest contract for project water on the American River system (150 taf/yr), which it had originally planned to receive via an extension of the existing Folsom South Canal. (EBMUD's American River supply is described in

TABLE 8-2

Sacramento River Region Water Budget (taf)[a]

	1995		*2020*	
	Average	***Drought***	***Average***	***Drought***
Water Use				
Urban	766	830	1,139	1,236
Agricultural	8,065	9,054	7,939	8,822
Environmental	5,833	4,223	5,839	4,225
Total	**14,664**	**14,106**	**14,917**	**14,282**
Supplies				
Surface Water	11,881	10,022	12,196	10,012
Groundwater	2,672	3,218	2,636	3,281
Recycled and Desalted	0	0	0	0
Total	**14,553**	**13,239**	**14,832**	**13,293**
Shortage	**111**	**867**	**85**	**989**

[a] Water use/supply totals and shortages may not sum due to rounding.

Monticello Dam, impounding Lake Berryessa, is the principal feature of USBR's Solano Project. Solano Irrigation District was formed in 1948 to sponsor construction of a reclamation project to serve Solano County.

Chapter 7.) Jenkinson Lake (Sly Park Dam) and Sugar Pine Reservoir serve communities in the foothills east of Sacramento.

Supply from Other Federal Water Projects

Monticello Dam in Napa County impounds Putah Creek to form Lake Berryessa, the principal water storage facility of USBR's Solano Project. The project provides urban and agricultural water supply to Solano County (partly in the Sacramento River Region and partly in the San Francisco Bay Region) and agricultural water supply to the University of California at Davis in Yolo County. Napa County uses about 1 percent of the supply for developments around Lake Berryessa.

Solano County Water Agency is the regional water contractor for both the federal Solano Project and the SWP. Within the Sacramento River Region, SCWA member entities with contracts for Solano Project water include the City of Vacaville (which also receives SWP water and uses groundwater), Solano Irrigation District and Maine Prairie Water District. (The Cities of Fairfield, Vallejo, and Suisun City in the San Francisco Bay Region have SCWA contracts for Solano Project water, as discussed in Chapter 7.) SID contracts for 141 taf/yr of Solano Project water from SCWA and delivers it to agricultural users in Solano County.

TABLE 8-3

Major Sacramento River CVP Water Users

Agency	*Total Supplies from CVP Facilities (taf)*
Anderson-Cottonwood ID	175.0
Glenn-Colusa ID	825.0
Natomas Central MWC	120.2
Princeton-Codora-Glenn ID	67.8
Reclamation District 108	232.0
Reclamation District 1004	71.4
Sutter Mutual WC	268.0

SWP Water Supply

Lake Davis, Frenchman Lake, and Antelope Lake are located on Feather River tributaries in Plumas County and are used primarily for recreation, but also provide water supply to the City of Portola and to local agencies having water rights agreements with the Department. Lake Oroville and Thermalito Afterbay also provide supply within the region. Local agencies that receive water rights water delivered through Thermalito Afterbay include Western Canal Water District, Richvale Irrigation District, Biggs-West Gridley Water District, Butte Water District, and Sutter Extension Water District. Agencies in the region holding long-term contracts for SWP supply are Plumas County Flood Control and Water Conservation District, Butte County, Yuba City, and SCWA. SCWA receives its SWP supply from the Delta through the North Bay Aqueduct.

Local Surface Water Supply

Water stored and released from Clear Lake and Indian Valley Reservoir into Cache Creek is diverted

Cache Creek, with Capay Diversion Dam in foreground. Clear Lake and Mount Konocti are in the background.

by the Yolo County Flood Control and Water Conservation District for irrigation in Yolo County. Since 1950, the district has diverted an average of 130 taf annually at Capay Diversion Dam on lower Cache Creek. No water supply from these sources was available during the 1977 and 1990 drought years.

In Sutter County and in western Placer County, agricultural water is supplied by South Sutter Water District from Camp Far West Reservoir on the lower Bear River. SSWD also purchases surface water from Nevada Irrigation District to supplement irrigators' groundwater supplies. NID's supplies come from its reservoirs on the Yuba-Bear River system. Yuba River supplies have also been developed by Yuba County Water Agency, which owns the 966 taf New Bullards Bar Reservoir, the river's largest reservoir.

The Sacramento metropolitan area, served by more than 20 water purveyors, is the largest urban area in the Sacramento Region and is also the largest urban surface water user. Within Sacramento County, the City of Sacramento relies primarily on surface water (approximately 80 to 90 percent); water purveyors in unincorporated areas use both surface water and groundwater. The City of Sacramento diverts its CVP water supply from the American River at H Street, and also diverts from the confluence of the American and Sacramento Rivers. The City of Folsom takes surface water from Folsom Lake.

Groundwater Supply

Most groundwater used in the region comes from alluvial aquifers on the valley floor. The Sacramento Valley is a major groundwater basin, with an estimated 114 maf of water in storage at depths of up to 600 feet. (Only a portion of this amount can be economically used, however.) Well yields in alluvial areas vary significantly depending on location; pumping rates typically range from 100 to 4,000 gpm. Foothill communities using groundwater generally rely on fractured rock sources having yields lower than those found in valley floor alluvium.

Redding supplements its CVP surface water supply with groundwater. Smaller communities in the northern and central Sacramento Valley, such as Anderson, Red Bluff, Marysville, Olivehurst, Wheatland, Willows, Corning, and Williams, rely almost entirely on groundwater and have adequate supplies to meet local demands for the foreseeable future. Woodland, Davis, and Dixon are completely dependent on groundwater. Most residents in unincorporated areas rely on groundwater.

In the Sacramento metropolitan area, groundwater is used by the Cities of Sacramento and Galt, Sacramento County, and local water agencies. Two areas of overdraft exist in Sacramento County, one near McClellan Air Force Base and the other in the Elk Grove area.

Local Water Resources Management Issues

Sierra Nevada Foothills Water Supply

Urbanization of agricultural lands in the Central Valley is an issue currently attracting public attention. An alternative to urban development on valley floor agricultural lands is increasing development on non-arable lands in the adjoining Sierra Nevada foothills. However, the foothill areas also have land use and water supply concerns associated with development pressure, particularly for communities within commuting distance of the valley's major population centers.

Historically the rural foothill counties have had economies based on natural resource development (ranching and logging). Tourism is becoming increasingly important. Although individual foothill communities have experienced relatively high growth rates, the area's overall population is small, and future development is constrained by the high percentage of federal lands managed by the USFS and the National Park Service.

Although extensive development of large-scale water projects has occurred in the foothills, that development serves downstream urban and agricultural water users. The foothills' local water supply infrastructure is limited, with some water users still being served by open ditch and flume systems dating back to gold rush-era mining operations. The area's development pattern of small, geographically dispersed population centers and its lack of a financial base for major capital improvement projects constrains the ability to interconnect individual water systems and to develop centralized sources of water supplies, limiting options for water marketing. The area's small population translates into high per capita costs for water supply improvements. Many individual residences and subdivision developments rely on self-supplied groundwater from wells tapping fractured rock aquifers. Groundwater resources from fractured rock sources are highly variable in terms of water quantity and quality, and are an uncertain source for large-scale residential development.

Management of existing water supplies, especially meeting increasingly stringent drinking water quality requirements, is a challenge for some foothill water systems. As with water supply, interconnections for water treatment purposes are difficult due to geographic and topographic constraints. System consolidations are also complicated by the relatively large percentage of the foothill population living in unincorporated areas, and the correspondingly high number of small, independent water systems. Historically, many isolated developments relying on groundwater as a source of supply also used septic tank systems for waste disposal. Eventually, some of these systems experience groundwater contamination problems, requiring a new water supply or connection to a regional wastewater system, if one exists.

Conveyance system reliability is a concern in foothill areas where sources of surface supply are often limited. Conveyance facilities are vulnerable to localized flooding and earthquake or landslide damage. After the 1997 floods, a landslide destroyed a 30-foot section of Georgetown Divide Public Utility District's canal which supplied water to 9,000 customers in six towns in rural El Dorado County. Nearby, El Dorado Irrigation District also lost the use of a flume diverting from the American River due to another landslide. The district is currently developing alternatives to repair or replace the flume. EID has released a draft EIR for the project, and is proposing to make temporary canal repairs to allow for 40 cfs summer deliveries until permanent repairs can be made.

The communities of Cohasset and Forest Ranch in Butte County are considering building a pipeline to convey part of Butte County's SWP supply to urban users east of Chico. During extended drought conditions some of the wells serving the area have gone dry, requiring that water be hauled by truck. Also in Butte County, the Department's Division of Safety of Dams reduced the allowable operating capacity of Paradise Irrigation District's Magalia Reservoir because of seismic safety concerns. The 2.9 taf capacity reservoir is impounded by a hydraulic fill dam built in 1918. Restoring the 1.5 taf reduction in storage capacity is estimated to cost about $10 million.

Through 2020, no average year water shortages are anticipated in the entire Sierra foothill area stretching from Modoc County on the north to Kern County on the south and including adjacent parts of the Cascade Range foothills. Drought year shortages in 2020 are forecast to be 220 taf, over 60 percent of which are associated with agricultural water use. The area's limited payment capacity and its need for drought year supplies suggests that participation in regional water supply projects with larger water agencies is a viable option. Although local agencies have evaluated a number of new reservoir projects in the past (see water management options section), these projects have not gone forward.

Foothill Area Water Supply from American River Basin

El Dorado County water agencies have made several attempts to develop local supplies in the American River Basin, in anticipation of their service area's future water needs. Originally, USBR's multipurpose Auburn Dam was to provide local supply. When Auburn Dam did not go forward, EID and El Dorado County Water Agency proposed a joint water supply and hydropower project in the late 1970s. The South Fork American River project would have included a large dam at the Alder Creek site, Texas Hill Reservoir on Weber Creek, two diversion dams, and several powerplants. When the SOFAR project did not prove to be financially feasible, a small Alder Creek Reservoir project with a storage capacity of 31 taf was investigated. In 1993, EDCWA released a final EIR for water supply development in EID's service area.

Many foothill areas are served by conveyance systems that had their origins in gold rush-era mining systems. Another reminder of the region's mining history is the ringtail, also known as the "miner's cat". Some early settlers kept ringtails as pets, to control mice. The ringtail lives in rocky and wooded areas in the foothills and in valley riparian areas.

Alternatives included a 7.5 taf/yr CVP water service contract for deliveries from Folsom Reservoir (authorized in PL 101-514), the El Dorado project, Texas Hill Reservoir, Small Alder Reservoir, and the White Rock project. The preferred alternative was identified as a combination of the water service contract, the El Dorado project, and the White Rock project.

EDCWA subsequently executed the CVP water service contract and EID sought to implement the El Dorado project, a proposal to acquire rights to consumptively use water that had been developed by PG&E for hydropower generation. In 1996, SWRCB's Decision 1635 approved EID's water rights filing for 17 taf/yr of consumptive use from PG&E's Caples, Aloha, and Silver Lakes on the South Fork of the American River and its tributaries, based in part on a PG&E agreement to sell facilities of the hydropower project to EID. Several other water right holders petitioned SWRCB to reconsider its decision. EID and PG&E subsequently went to litigation over the sale of the facilities, and EID's EIR for the El Dorado project was found inadequate by a Superior Court judge. The project is currently on hold.

EID's White Rock project is a diversion and conveyance project that would build about 4.5 miles of pipeline, connecting a proposed treatment plant with an existing Sacramento Municipal Utility District penstock. The project would allow more efficient use of El Dorado project water, but would not provide additional water supply.

Alternatives to meeting GDPUD's future water needs were identified in a 1992 planning report that examined a potential reservoir project on Canyon Creek. The reservoir project was found to be unaffordable for the service area. The most promising option to meet future water demands in GDPUD's service area is to divert and convey CVP water from the American River (as part of EDCWA's CVP water service contract authorized by PL 101-514). The additional supplies would be 7.5 and 5.6 taf for average and drought years, respectively.

In the 1990s, USBR conducted an American River water resources investigation to evaluate local area water supply options that would replace the water supply that was to have been provided by the original multipurpose Auburn Dam. The study proposed two alternatives for meeting municipal and agricultural water supply needs in portions of Sacramento, San Joaquin, El Dorado, Placer, and Sutter Counties through 2030—a conjunctive use alternative and an Auburn Dam alternative. Three alternative Auburn Reservoir sizes were studied: 430 taf, 900 taf, and 1,200 taf. The final EIS for this investigation was completed in 1997. In May 1998, USBR issued a record of decision to not proceed with federal actions to meet future water needs in the study area.

Sacramento Area Water Forum

The Sacramento Area Water Forum was formed in 1993 to discuss ways to accommodate two co-equal objectives, providing water supply for the area's planned development and preserving fishery, wildlife, recreational, and aesthetic values of the lower American River. Forum membership includes the Cities of Sacramento, Galt, and Folsom; County of Sacramento; more than twenty urban and agricultural water agencies; several environmental groups; and representatives from the business community and other community groups. In 1995 the forum began meeting jointly with water interests in Placer and El Dorado Counties.

Working together, they developed proposed draft recommendations for their objectives, releasing a *Draft Recommendations for a Water Forum Agreement* in 1997. The proposed solution included seven elements:

- Increased surface water diversions
- Actions to meet customers' needs while reducing diversion impacts on the Lower American River in drier years
- Support for an improved pattern of fishery flow releases from Folsom Reservoir
- Lower American River habitat management
- Water conservation
- Groundwater management
- Water Forum successor effort

Generally, water interests would increase their diversions from the American River in average and wet years and decrease diversions in drought years. PCWA would release stored water from its reservoirs on the Middle Fork of the American River for many of the participating water agencies during drought years as replacement water for their decreased American River diversions. PCWA's participation in these agreements is dependent upon SWRCB approval for changes to conditions of its existing water rights.

The proposal calls for conjunctively managing surface and groundwater supplies to help control declining groundwater levels in parts of Sacramento County, and for implementing water conservation measures. An example of the regional cooperation for stabilizing groundwater levels is a joint pipeline project being carried out by San Juan Water District and Northridge Water District. SJWD has completed the first phase and NWD has completed the second phase of a joint pipeline project which will provide surface water to northern Sacramento County water purveyors. Phase III would extend the pipeline to the Rio Linda WD, McClellan AFB, the westerly Citizen's Utilities service area, and Natomas Central Mutual Water Company area. By providing surface water supplies, the retail purveyors along the pipeline route can reduce their dependence on groundwater, allowing the groundwater basin to recharge.

Colusa Basin Drainage District

A 1995 study by the Colusa Basin Drainage District identified projects to meet six objectives: protect against flood and drainage damages, preserve and enhance agricultural production, capture surface or storm water for increased water supplies, facilitate groundwater recharge to help reduce overdraft and land subsidence, improve and enhance wetland and riparian habitat, and improve water quality. Some projects selected for feasibility and preliminary design studies have potential water supply benefits—two small onstream reservoirs and one groundwater recharge project. These projects are described in the discussion of water management options. Much of the present supply for agricultural water users in the Colusa Basin comes from return flows from CVP water contractors. These irrigation return flows have become an increasingly unreliable supply for Colusa Basin Drain diverters as a result of increased water conservation measures by upstream water users.

Groundwater Management Actions

The Sierra Valley Groundwater Management District adopted an ordinance in 1980 limiting the amount of groundwater extraction in Sierra Valley. A legal challenge led to a repeal of the ordinance by the SVGMD. The district has since focused its efforts on monitoring the basin's groundwater levels and requesting voluntary reductions in extractions.

In 1992, the Tehama County Board of Supervisors amended its county code to enact urgency ordinances prohibiting groundwater mining within the county and extraction of groundwater for export without a permit from the board. In 1996, the Tehama County Flood Control and Water Conservation District adopted a resolution of intent to develop a countywide AB 3030 plan and prepared a draft plan to serve as the basis for developing agreements with groundwater users.

Butte County has enacted two ordinances regulating groundwater extraction. The purpose of one ordinance was to "attempt to reduce potential well interference problems to existing wells and potential adverse impacts to the environment which could be caused by the construction of new wells or the repair or deepening of existing wells. . . ." The ordinance limited pumping rates to 50 gpm per acre. The ordinance also established well spacing requirements based on well pumping capacity; spacing requirements range from 450 feet for a 1,000 gpm well to 2,600 feet for a 5,000 gpm well. The other ordinance was approved by voters in 1996 and regulated export of groundwater out of the county and substitution of groundwater for surface water when surface water is sold. The ordinance gave the Butte County Water Commission permitting authority over groundwater export or groundwater substitution.

Glenn County enacted a groundwater ordinance in 1977. This ordinance required a permit to export groundwater outside the county. A permit can be issued only if it is found that export will not result in overdraft, adverse impacts to water levels, or water quality degradation. The Board of Supervisors may impose permit conditions. Glenn County is preparing an AB 3030 groundwater management plan that is expected to be completed in 1998.

American River Flood Protection

Following the floods of February 1986, USACE reanalyzed American River basin hydrology and concluded that Folsom Dam did not provide an adequate level of flood protection to the downstream Sacramento area, significantly less than the 250-year protection estimated in the late 1940s when Folsom Dam was designed. Local, State, and federal agencies worked together to identify ways to provide additional flood protection for the American River Basin. In December 1991, an American River watershed investigation feasibility report and EIR/EIS were completed, presenting flood protection alternatives. The report recommended a flood control detention dam near Auburn. In 1992, Congress directed USACE to perform additional flood control studies. Three main alternatives were evaluated. Two of the alternatives would increase flood control storage in Folsom Lake, modify the dam's spillway and outlet works, and improve downstream levees. The third alternative would construct a detention dam at Auburn, with downstream levee improvements. USACE studies identified the detention dam as the plan that maximized national economic benefits. The State Reclamation Board endorsed the detention dam as the best long-term solution to reliably provide greater than 1-in-200 year flood protection. In 1996, USACE recommended deferring a decision on long-term solutions and proceeding with the levee improvements common to all three alternatives. Congress authorized $57 million in 1996 for construction of the levee improvements.

The Central Valley's January 1997 flood disaster prompted another examination of American River hydrology. Based on that hydrologic review, the 1986 and 1997 floods are now considered to be about 60-year events. The 1997 flooding also triggered payback provisions of the Sacramento Area Flood Control Agency's agreement with USBR, under which USBR sets aside up to 270 taf of additional winter flood control space in Folsom Lake. (This additional flood control space in the reservoir raises Sacramento's level of protection to about a 77-year event level.) Because the January 1997 flood event was followed by an unusually dry spring, reoperation of Folsom Lake for additional flood control resulted in a loss of supply to USBR. The federal government and SAFCA purchased 100 taf to offset the loss of supply—50 taf from YCWA, 35 taf from PCWA, and 15 taf from GCID.

In its Resolution No. 98-04, the Reclamation Board restated its conclusion that the best long-term engineering solution to reliably provide greater than 1-in-200 year flood protection is to develop additional flood detention storage at Auburn. As an incremental measure to increase the level of flood protection, the Board also voted to support SAFCA's Folsom Modification Plan, described in SAFCA's February 1998 report *Next Steps for Flood Control along the American River.* This plan, costing $75 to $140 million, would

Sacramento River Flood Control Project

Congress authorized the Sacramento River Flood Control Project in 1917 after a series of major Sacramento Valley floods in the late 1800s and early 1900s. The project was built with local, State, and federal funding. The project includes levees, overflow weirs, bypass channels, and channel enlargements. Overflow weirs allow excess water in the main river channel to flow into bypasses in the Sutter Basin and Yolo Basin. The bypass system was designed to carry 600,000 cfs of floodwater past Sacramento—110,000 cfs in the Sacramento River through downtown Sacramento and West Sacramento, and the remainder in the Yolo Bypass. The system has worked exceedingly well over the years.

The capability of the SRFCP was improved upon completion of Shasta Dam in 1945 and Folsom Dam in 1956. The Feather and Yuba River systems did not share in the SRFCP's flood control benefits; however, supplemental protection was provided by the completion of Oroville Dam on the Feather River in 1968 and New Bullards Bar Dam on the Yuba River in 1970. These are large multipurpose reservoirs in which flood control functions share space with water supply functions.

The City of Sacramento experienced several major floods during its early years. The following description of the floods of 1862 is taken from the journal of William Brewer, a member of the California State Geological Survey. "Such a desolate scene I hope never to see again. Most of the city is still under water, and has been for three months. ... Not a road leading from the city is passable, business is at a dead standstill, everything looks forlorn and wretched. Many houses have partially toppled over... some have been carried from their foundations, several streets (now avenues of water) are blocked up with houses that have floated in them, dead animals lie about here and there. . . ."

Courtesy of California State Library

increase flood protection to approximately a 1-in-110 year level. In addition, the Board strongly urged SAFCA to advocate federal flood insurance for all residents and businesses in the Sacramento area having less than a 1-in-200 year level of flood protection. As of July 1998, SAFCA was seeking congressional authorization for USACE participation in Folsom Dam modifications and downstream levee enlargements. The Board currently does not support raising and strengthening the levees downstream from the dam, and would not support State cost-sharing in this effort. Two competing flood control bills, HR 4111 and HR 3698, are pending before Congress. HR 4111 would authorize construction of a small flood control dam, while HR 3698 would rely mostly on levee improvements for flood protection for the Sacramento area.

Yuba River Flood Protection

The Marysville-Yuba City area, located at the confluence of the Feather and Yuba Rivers, relies on levees for much of its flood protection. New Bullards Bar Reservoir on the Yuba River, the only Yuba River Basin reservoir with dedicated flood control storage, regulates less than half the river's runoff. The middle and south forks of the Yuba River, and Deer Creek, have no dedicated flood storage. A large reservoir site (the former Marysville project, and similar sites near the Yuba River Narrows) was studied by USACE, YCWA, the Department, and others at various times in the 1950s and through the 1980s for both water supply and flood control purposes.

USACE, in cooperation with the State Reclamation Board and YCWA, conducted a feasibility study of water resources problems and opportunities in the Yuba River Basin in 1991, after a 1990 reconnaissance study identified a significant flood threat. Preliminary alternatives included modifying existing levees, implementing nonstructural measures, constructing a large or small bypass, reregulating existing flood storage at Oroville and New Bullards Bar Reservoirs, providing new flood storage at Englebright Reservoir, raising Englebright Dam and reregulating flood storage at Englebright and New Bullards Bar Reservoirs, and constructing a single purpose or multipurpose reservoir at the Parks Bar or Narrows damsites. The recommended plan in USACE's 1998 Yuba River Ba-

Flooding on the American River in 1986 and again in 1997 severely tested levee system capabilities. Releases from Folsom Dam in 1986 actually exceeded design capacity of the levee system. In 1997, voluntary evacuation advisories were issued for some parts of the Sacramento metropolitan area. This photo shows the American River at the H Street bridge.

sin Investigation final feasibility report and EIR/EIS was to modify existing levees along the Yuba and Feather Rivers. In response to the significant flood problems experienced in the Marysville-Yuba City area during the January 1997 flood, YCWA began a new investigation of flood control alternatives. The multi-year study will examine a range of alternatives, including storage facilities such as the Parks Bar site. During the 1997 flood event, 35,000 people were evacuated from the Marysville area and 75,000 people were evacuated downstream in Sutter County.

Sacramento River Mainstem Flood Protection and Water Supply

Enlargement of Shasta Reservoir has been examined in the past by USBR and the Department as a water supply option. Reservoir enlargement would also provide additional flood protection on the Sacramento River mainstem. When the project was last reviewed in the 1980s (at a cursory level of detail), its financial costs were high, reflecting the project's magnitude (up to 10 maf of additional storage capacity). Railroad and highway relocations were a substantial cost item. In the wake of the January 1997 flooding, there was renewed interest in reexamining Shasta's enlargement, and in considering a range of potential reservoir sizes. USBR conducted a preliminary study for the CALFED program, reviewing three options. One option would raise the dam 6 feet to add 300 taf of storage at a cost of $123 million. Raising the dam 100 feet would add 4 maf of storage and cost $3.9 billion. Raising the dam 200 feet would add 9.3 maf of storage and cost $5.8 billion. Enlarging Shasta as a statewide water management option could provide the opportunity for local agencies in the region to participate in the project, especially smaller agencies that lack the resources to develop new local projects themselves.

Putah Creek Adjudication

USBR's Solano Project stores and diverts water from Putah Creek. Solano Project operations are subject to a condition reserving water for users upstream of Monticello Dam in Lake Berryessa. In 1990, two project water users (SID and SCWA) commenced an action in Solano County Superior Court to determine all rights to the use of water from Putah Creek and its tributaries. Among other issues, the action required a determination of how rights can be exercised among USBR and upstream water users. An agreement was negotiated among SID, SCWA, USBR, and upstream water users. In 1996, the SWRCB adopted Order WR 96-2, amending appropriative water rights in the upper Putah Creek watershed to be consistent with the negotiated agreement.

Fish Passage at Red Bluff Diversion Dam

USBR's Red Bluff Diversion Dam, completed in 1966, spans the Sacramento River. The dam diverts river water into the Tehama-Colusa and Corning Canals, supplying irrigation and wildlife refuge water. Severe fishery declines in the upper river during the 1970s and 1980s, were partly attributed to the dam and the canal intake screens. The dam delayed upstream passage of migrating adult salmon and steelhead and disoriented downstream migrating juveniles, which made them vulnerable to predation by squawfish. The original fish screens also permitted passage of many juvenile fish into the canals.

In 1986, USBR began raising the gates of the dam between December and March to allow unimpeded fish passage. The gates-up period has been expanded in response to ESA requirements for winter-run chinook salmon; the current objective is to raise the gates for eight consecutive months (September 15 to May 15) each year to allow unimpeded fish passage. New drum fish screens and bypasses were installed at the canal headworks in 1991 and are now operating successfully. As discussed in Chapter 2, USBR and USFWS are operating a research pumping plant at the dam to evaluate the effects of different pump types on fish. The plant supplies a limited amount of water to the canals during the eight months when the dam gates are raised.

Glenn-Colusa Irrigation District Fish Screen

The 175,000 acre Glenn-Colusa Irrigation District has the largest diversion on the mainstem Sacramento River, with a maximum capacity of 3,000 cfs. GCID may divert up to 825 taf from April through October for irrigation supply. GCID also conveys CVP water to three national wildlife refuges—Sacramento, Delevan, and Colusa.

GCID's pumping plant is located on a river side channel upstream of Hamilton City, near Chico. DFG constructed a 40-drum rotary screen fish barrier at the plant's intake in 1982, to prevent entrainment of juvenile fish. The fish barrier did not perform as intended, resulting in an unacceptably high rate of juvenile fish mortality. ESA listing of the winter-run chinook salmon resulted in a 1991 court order restricting GCID's pumping and requiring installation of a new fish screen. CVPIA required DOI to improve fish passage at the pumping plant. GCID installed a temporary flat-plate screen in 1993 while a permanent solution was being developed. An environmental document identifying a preferred fish passage alternative—a new flat-plate screen with a river gradient control facility in the main channel of the Sacramento River—was released in 1997. Construction of the new screen began in 1998.

Fish and Wildlife Restoration Activities in the Sacramento Valley

Many fishery restoration actions or projects are ongoing in the Sacramento Valley. Some of the larger projects are described below.

Mill and Deer Creeks support spring-run chinook salmon, a candidate species under the California ESA. In 1995, State legislation restricted future water development on the creeks, to protect salmon habitat. In addition, local landowners formed the Mill and Deer Creek Watershed Conservancies. The conservancies

USBR's Red Bluff Diversion Dam, with gates raised. The dam was designed to divert Sacramento River water into the Tehama-Colusa Canal. The intake channel for the Corning Canal Pumping Plant connects to the Tehama-Colusa Canal.

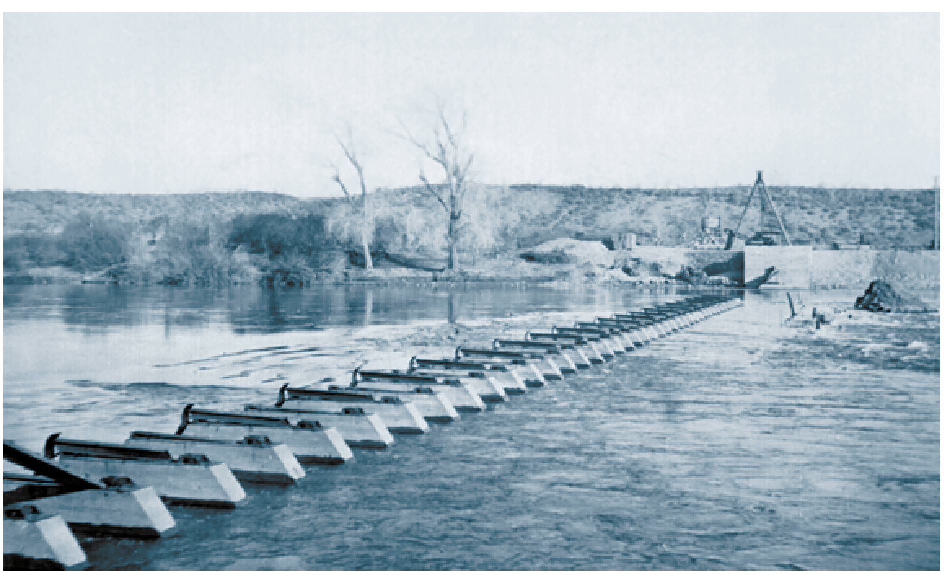
Local agencies have made extensive efforts to improve Butte Creek fish passage, in response to declines in the population of spring-run chinook salmon.

have begun a watershed planning and management process, with funding assistance from an EPA grant. The Department has participated with Mill Creek landowners in a test project to construct wells to provide groundwater supplies in lieu of creek diversions for irrigation during spring fish migration periods. A similar project is being negotiated with Deer Creek water users.

Big Chico Creek supports a small population of spring-run salmon, and some fall-run salmon. M&T Chico Ranch and Parrott Ranch pumps were relocated from the creek to the Sacramento River in 1996 to eliminate reverse flows at the mouth of the creek. Other fishery improvement actions—modification of small temporary dams and a permanent fish ladder, revegetation of Lindo Channel, and development of a fishery management plan—are being investigated.

Butte Creek is presently receiving considerable fishery restoration attention. The creek has a large spring-run salmon population and also supports a small fall run. Recent fishery restoration efforts on Butte Creek began in 1993 when Western Canal Water District and private landowners agreed to remove the Point Four Diversion Dam near Nelson. M&T Chico Ranch and DFG agreed to install a new fish ladder and fish screens at the Parrott-Phelan Dam in 1995. M&T Chico Ranch also dedicated 40 cfs of instream flow for fishery needs on Butte Creek. WCWD installed a siphon under Butte Creek in 1998, allowing removal of its two main dams and two smaller downstream dams from the creek. The siphon separates WCWD's canal system from Butte Creek and eliminates fish losses previously caused by creek diversion. Work began in 1998 on fishery facility modifications to Durham Mutual, Adams, and Gorrill Dams. The Nature Conservancy and California Waterfowl Association are evaluating diversion dams in the Butte Slough and Sutter Bypass for potential fish passage improvements.

Pelger Mutual Water Company and Maxwell Irrigation District installed fish screens on their Sacramento River diversions in 1994. Princeton-Codora-Glenn Irrigation District and Provident



A 1917 construction photo of Anderson-Cottonwood Irrigation District's diversion dam on the Sacramento River. Flashboards are installed during the irrigation season to raise the river's water level for diversions to ACID's main canal. ACID's diversion is one of many Sacramento River Basin sites under study for fish passage Improvements.

Courtesy of Water Resources Center Archives, University of California, Berkeley

Irrigation District started construction on a new screened pumping plant on the Sacramento River, which is expected to be operational in 1998. Reclamation District 108 started building its new fish screen at its Wilkins Slough Diversion on the Sacramento River in 1997. The new screen is expected to be operational in 1999. Reclamation District 1004 is completing final design and will begin construction on its new fish screen and pumping facility in 1998. Natomas Central Mutual Water Company will soon begin feasibility studies for a large screening project on the lower Sacramento River. On the Yuba River, Browns Valley Irrigation District will install a fish screen in 1998.

Clear Creek is another location in the Sacramento River Basin where fishery restoration work has been performed. Additional planned work includes fish passage around McCormick-Saeltzer Dam, gravel placement, and sediment control. Much of the riparian land along Clear Creek below Whiskeytown Reservoir has been acquired by BLM and the Wildlife Conservation Board to preserve its habitat values.

Other Sacramento River Region streams with environmental restoration studies underway are Battle Creek and Lower Stony Creek. Potential restoration work at Battle Creek includes studies of fish passage, instream flows, screened diversions, and hatchery modernization. Glenn County is seeking funding for planning of a Lower Stony Creek watershed restoration program.

Water Needs for Rice Field Flooding

Sacramento Valley rice fields provide overwintering areas for about one-third of all migrating waterfowl in California. Historically, many farmers in the Sacramento Valley have flooded harvested rice fields to attract waterfowl for hunting. Additional rice acreage is now being flooded for rice straw decomposition, due to air quality restrictions on burning rice straw. Most flooding of harvested rice lands begins in mid-October and continues into November. Flooded conditions are usually maintained through March. In 1994-95, the Department studied three Sacramento Valley planning subareas (Northwest Valley, Central Basin West, and Central Basin East) to evaluate fall and winter water use. The study area included approximately 123,000 acres of flooded rice land. The estimated applied water requirement was 260 taf or about 2 af/acre; the estimated ETAW was 107 taf. Fields used for waterfowl hunting have higher water demands than those used for rice straw decomposition. Water demands for flooding to decompose rice straw may decrease in the future if growers are able to find commercial uses for rice straw.

Water Management Options for the Sacramento River Region

Water management options in the Sacramento River Region have been extensively investigated by federal, State and local governments over the last 70 years. Many of the federal and State options were explored for their potential to augment CVP or SWP water supplies. Some projects, once studied as statewide options, are now being reconsidered for meeting future local water supply and flood control needs in the Sacramento River Region. Most large onstream and offstream reservoirs are beyond the development capacity of local water agencies, and are being considered as CALFED options, described in Chapter 6.

Table 8-4 shows a list of options for the region, and the results of an initial screening of the options. The retained options were evaluated (Table 8A-1 in Appendix 8A) based on a set of fixed criteria discussed in Chapter 6.

Water Conservation

Urban. Urban water demand forecasts for 2020 assume that BMPs are in place; consequently, only those urban conservation efforts which exceed BMPs are considered as options. Urban conservation options were deferred from detailed evaluation because they provide little cost-effective potential to create new water through depletion reductions in the Sacramento River Region.

Agricultural. The 2020 agricultural water demand forecasts assume that EWMPs are in place. As with the urban water management options, only those agricultural conservation efforts which exceed EWMPs are considered as options. Agricultural conservation options were deferred. Water that is not consumed by evapotranspiration is recoverable either as surface or groundwater for reapplication downstream.

Modify Existing Reservoirs/Operations

Two reservoir enlargement options were deferred in initial screening. Enlargement of Camp Far West Reservoir was deferred based on economic criteria. A Lower Bear River expansion project that would increase the storage of Lower Bear Reservoir by more than 26 taf was deferred because of several uncertainties includ-

TABLE 8-4

Sacramento River Region List of Water Management Options

Option	*Retain or Defer*	*Reason for Deferral*
Conservation		
Urban		
Outdoor Water Use to 0.8 ET_o	Defer	No significant depletion reductions attainable.
Indoor Water Use	Defer	No significant depletion reductions attainable.
Interior CII Water Use	Defer	No significant depletion reductions attainable.
Distribution System Losses	Defer	No significant depletion reductions attainable.
Agricultural		
Seasonal Application Efficiency Improvements	Defer	No significant depletion reductions attainable.
Flexible Water Delivery	Defer	No significant depletion reductions attainable.
Canal Lining and Piping	Defer	No significant depletion reductions attainable.
Tailwater Recovery	Defer	No significant depletion reductions attainable.
Modify Existing Reservoirs/Operations		
Enlarge Camp Far West Reservoir	Defer	Economics.
Lower Bear River Expansion Project	Defer	Uncertainties with water rights issues.
Reoperate Caples, Aloha, and Silver Lakes	Retain	
New Reservoirs/Conveyance Facilities		
Wilson Creek Reservoir (Glenn County)	Defer	Undetermined yields; primarily flood control project.
Golden Gate Reservoir (Funks Creek, Colusa County)	Defer	Undetermined yields; primarily flood control project.
Dry Creek Reservoir (Lake County)	Retain	
Bear Creek Reservoir (Colusa County)	Defer	Environmental concerns. Conflicts with federal land management policies.
Wilson Valley Reservoir (Lake County)	Defer	Environmental concerns. Conflicts with federal land management policies.
Garden Bar Reservoir (Placer and Nevada Counties)	Defer	Economics.
Long Bar Reservoir (Yuba County)	Defer	Undetermined yields; primarily hydropower project.
Wambo Bar Reservoir (Yuba County)	Defer	Undetermined yields; primarily hydropower project.
Marysville Dam (Yuba County)	Defer	Undetermined yields; economics.
Blue Ridge Reservoir (Yolo County)	Defer	Environmental concerns. Conflicts with federal land management policies.
Thurston Lake Pump-Storage Project (Lake County)	Retain	
Parks Bar Reservoir (Yuba County)	Retain	
Waldo Reservoir (Yuba County)	Retain	
White Rock Project (El Dorado County)	Defer	Reoperation of existing supply; would not provide new water supply.
Texas Hill Reservoir (El Dorado County)	Retain	
Small Alder Reservoir (El Dorado County)	Retain	
Canyon Creek Reservoir (Georgetown)	Defer	Excessive costs.
GDPUD Diversion from American River	Retain	

TABLE 8-4

Sacramento River Region List of Water Management Options (continued)

Option	*Retain or Defer*	*Reason for Deferral*
Groundwater/Conjunctive Use		
New Wells (Redding, Butte, and Colusa Basins)	Retain	
USBR/Ducks Unlimited Conjunctive Use	Defer	Would not create new water supply.
Big Valley Conjunctive Use (Lake County)	Retain	
Orland-Artois Groundwater Recharge Basin	Defer	Lack of project data, no yields determined.
Adobe Creek Detention Structure (Lake County)	Defer	Negative environmental impacts.
Water Recycling		
Water recycling options	Defer	Water recycling options would not generate new water supply.
Desalting		
Brackish Groundwater		
—	—	—
Seawater		
—	—	—
Other Local Options		
New Surface Water Diversion from Sacramento River and Cache Creek by YCFC&WCD	Retain	
New Surface Water Diversion from Sacramento River by Cities of Benicia, Fairfield, and Vacaville	Retain	
Statewide Options		
—	—	See Chapter 6.

ing water rights issues, coordination with PG&E (the reservoir's owner), and lack of definitive estimates of the project's drought year supply.

The water management issues section described several projects for EID's service area. The El Dorado Project would offer an annual yield of 17 taf for EID through consumptive use of water developed for hydropower at PG&E facilities (Caples, Aloha, and Silver Lakes). No new diversion facilities would be required for the project. Implementation of the El Dorado Project is currently on hold pending negotiations with project opponents.

New Reservoirs

An extensive reevaluation of onstream and offstream Sacramento Valley reservoir sites is being conducted by the CALFED Bay-Delta program. Chapter 6 discusses reservoir sites (such as the offstream Sites Reservoir) being evaluated as statewide water supply options for CALFED.

Onstream Storage. Local efforts to develop American River Basin water supply for rapidly growing foothill communities were described previously. Most recently, EID and EDCWA considered the Texas Hill and Small Alder Reservoir sites, but EDCWA did not include them as preferred alternatives in its plan for EID's service area. The drought year yields from these reservoirs have been estimated at 9.4 taf and 11.3 taf, respectively. If implementation of EDCWA's preferred alternative does not proceed, these options may still be viable. GDPUD has examined a reservoir project on Canyon Creek. The 17 taf reservoir site, located between the Middle and South Forks of the American River, would have an estimated drought year yield of 6 taf. This project was not cost-competitive with other options available to GDPUD.

The Colusa Basin Drainage District has investigated two small reservoirs as part of its integrated watershed management project—a 2.2 taf Wilson Creek Reservoir west of Orland in Glenn County, and

Sites Reservoir (described in Chapter 6 as a CALFED option) could provide some local supply for the region, depending on the project's formulation. This photo shows the dam site area.

a 16.9 taf Golden Gate Reservoir on Funks Creek near Maxwell in Colusa County. The estimated average annual runoff at the Wilson Creek site is 2.4 taf. The construction cost is estimated at $3.3 million. The primary purpose of the proposed reservoir would be flood control, although it offers limited water supply benefits. Golden Gate Reservoir would be formed by a 76-foot high earthfill dam; this dam site is also a component of the Sites/Colusa Reservoir, a CALFED storage option presented in Chapter 6. The estimated average annual runoff at the Golden Gate Dam site is 8.6 taf and the construction cost estimate for the dam and reservoir is $2.5 million. Neither of these projects is included in the Bulletin's detailed options evaluation because potential yields are undetermined. These reservoirs are too small to provide enough carryover storage to significantly increase local drought year water supply reliability.

The Department investigated the Dry Creek Project in Lake County near Middletown in 1965. The project was designed to irrigate 5,700 acres of agricultural lands in the Collayomi and Long Valleys in Lake County. The main project feature would be a 129-foot-high earthfill dam on Dry Creek (a Putah Creek tributary) forming a 6.6 taf reservoir. Updated cost estimates range from $150 to $250/af, assuming a maximum annual yield of 6.6 taf. USACE is conducting a reconnaissance study for a similar facility, scheduled for completion in 1998.

In 1988, YCFC&WCD studied alternative water supply projects in the Cache Creek watershed. The study identified three onstream storage projects—Bear Creek Reservoir in Colusa County and Wilson Valley Reservoir in Lake County, with annual yields of 30 taf each, and Blue Ridge Reservoir in Yolo County, with an annual yield of 100 taf. None of these sites are under active consideration now. Parts of the Cache Creek drainage basin that could be impacted by these projects are managed by BLM and DFG for wildlife habitat and recreational purposes, and a segment of Cache Creek is under study for potential federal designation as a wild and scenic river.

South Sutter Water District had looked at a potential Garden Bar Reservoir on the Bear River, upstream of Camp Far West Reservoir and had determined that the project was not economically feasible.

Many potential Yuba River reservoir sites have been studied to meet basin flood protection and water supply needs. Recent local interest has focused on the Parks Bar Reservoir site on the lower Yuba River (below Englebright Dam) and on Waldo Reservoir, an offstream storage option discussed in the next section. The potential multipurpose Parks Bar Reservoir would have a 640 taf capacity and could provide up to 160 taf of drought year yield. Parks Bar Dam is a flood control alternative previously rejected by the USACE in favor of levee improvements. YCWA is starting a new three-year study to evaluate all basin flood control and water supply options. The study will reevaluate levee improvements, new flood control channels, new storage (including Parks Bar), and reoperation of existing reservoirs.

Offstream Storage. In 1996, YCWA completed a reconnaissance evaluation of the proposed 300 taf offstream Waldo Reservoir. Waldo Dam would be located on Dry Creek, east of Beale Air Force Base in Yuba County. Water would be diverted from the Yuba River by gravity through a tunnel from Englebright Reservoir. The dam would provide flood control benefits on Dry Creek for the City of Wheatland, but would have no direct flood control benefits on the Yuba River. Waldo Reservoir could provide offsetting storage for increased flood control reservation at New Bullards Bar Reservoir and Lake Oroville if YCWA negotiates agreements with the reservoir owners for supply from Waldo Reservoir in exchange for the flood control storage.

Phase I of a feasibility investigation was conducted in 1997 to determine reservoir yield, develop cost estimates, and evaluate environmental issues. The reservoir's average and drought year yields for YCWA's service area would be about 145 and 109 taf, respectively. The cost of water if served in the area of origin would be about $110/af. Phase II of the study began in 1998 and includes analyses of alternatives. Preparation of environmental documentation would begin in 2000 if the project appeared feasible. Environmental issues include flooding of a portion of the Spenceville Wildlife and Recreation Area, remediation of an abandoned copper mine, and instream flows. (The preliminary cost estimates include removal of mine tailings and site remediation in accordance with regulatory requirements.)

A 1988 YCFC&WCD study investigated a potential offstream storage project at Thurston Lake, a natural lake in the Clear Lake watershed. The Thurston Lake pump-storage project was to develop a new water supply and reduce flooding at Clear Lake communities. The project would provide storage of up to 300 taf and yield 60 taf/yr. Water would be pumped from Clear Lake into Thurston Lake during periods of high runoff, reducing downstream flood flows. Preliminary investigations suggest that substantial leakage at the site would occur and that potential water quality problems could result from high boron levels in Thurston Lake.

New Conveyance Facilities

The White Rock conveyance project would divert and convey South Fork American River water from SMUD's White Rock Penstock to EID's proposed Bray Water Treatment Plant near Diamond Springs. The diversion could be made under a 1957 contract and a 1961 supplemental agreement with SMUD, if water rights were granted by SWRCB to EDCWA and EID. The maximum quantity of water that could be diverted annually is about 40 taf. The project would not generate new water.

Groundwater Development or Conjunctive Use

Groundwater is expected to be the primary local option for increasing valley floor water supplies north of Sacramento within this Bulletin's planning horizon. Where supplies are plentiful and of adequate quality, groundwater has a cost advantage over new reservoirs. Groundwater can be developed incrementally by individual farms and domestic users, or by water purveyors. Data are not available to quantify the availability of additional groundwater development.

USBR, in cooperation with Ducks Unlimited, studied a conjunctive use project within GCID to provide long-term groundwater supply to supplement available surface water for rice straw decomposition and waterfowl habitat. In wet years, surplus Sacramento River water would be pumped into GCID's conveyance system for delivery to recharge areas. The study concluded that the project would not provide new water supply.

The Lake County Flood Control and Water Conservation District is investigating a small conjunctive use project in Big Valley near Kelseyville. This project would modify the primary spillway structure of Highland Creek Reservoir to increase storage. The conserved water would be released downstream during the spring and fall for groundwater recharge. Current estimates indicate a project yield of 400 af/yr at a cost of about $30/af. Because the yield would be less than 1 taf/yr, the project was not shown in the list of options likely to be implemented for the region.

The Colusa Basin Drainage District is investigating the Orland-Artois groundwater recharge project in southern Glenn County. Water would be delivered to an abandoned quarry via the Tehama-Colusa Canal during periods of high Sacramento River flows. Preliminary designs for this project estimate groundwater recharge capacity of 1.5 taf per season. The estimated cost of construction ranges from about $363,000 to $513,000. Evaluation of this option was deferred until project yields are determined.

Water Marketing

Intra- and inter-district water transfers have been common among CVP water rights settlement contractors on the Sacramento River. Year-to-year transfers among CVP water users in the region are not considered as new projects for Bulletin 160-98.

Water Recycling

As with conservation, recycling is not a source of new supply in the Sacramento River Region from a statewide perspective. Recycling is a potentially important water source for local purposes, but does not create new water. Several small water recycling projects serve local water needs for agricultural, environmental, and landscape irrigation purposes. In the 1995 base year, about 12.5 taf of wastewater was recycled in the region, an amount expected to increase to 14.5 taf by 2020.

Other Local Options

YCFC&WCD has filed water right applications for supplemental water from the Sacramento River for

Davis, Woodland, and Winters, and for agricultural and fishery uses at UC Davis. YCFC&WCD also filed an application to divert water from Cache Creek for groundwater recharge and to replace groundwater currently being used for irrigation. About 95 taf has been requested under the two applications.

SCWA and its member agencies are examining several surface water management projects. One potential project is an intertie connecting a Solano Irrigation District irrigation canal with the SWP's North Bay Aqueduct. Another potential SCWA project involves permanent or long-term water transfers. The Cities of Fairfield and Benicia in the San Francisco Bay Region and Vacaville in the Sacramento River Region have filed a water right application for supplemental water from the Sacramento River, seeking 12, 10.5, and 8.5 taf/yr, respectively.

Statewide Options

Statewide water supply augmentation options are discussed and quantified in Chapter 6.

Options Likely to be Implemented in the Sacramento River Region

Water supplies are not available to meet all of the region's 2020 water demands in average or drought years. Applied water shortages are forecasted to be 85 taf and 989 taf in average and drought years, respectively. Ranking of retained water management options for the Sacramento River Region is summarized in Table 8-5. Table 8-6 summarizes options that can likely be implemented by 2020 to relieve the shortages.

Costs of new reservoir projects are often prohibitive for agricultural water users, especially when the

TABLE 8-5

Options Ranking for Sacramento River Region

Option[a]	*Rank*	*Cost ($/af)*	*Potential Gain (taf)*	
			Average	*Drought*
Modify Existing Reservoirs/Operations				
Reoperate PG&E Reservoirs	L	[b]	[b]	17
New Reservoirs/Conveyance Facilities				
Dry Creek Reservoir (Lake County)	L	200	7	[b]
Thurston Lake Pump-Storage Project	M	390	[b]	60
Parks Bar Reservoir (Yuba County)	H	[b]	[b]	160
Waldo Reservoir (Yuba County)	H	110	145	109
Texas Hill Reservoir (El Dorado County)	L	[b]	[b]	9
Small Alder Reservoir (El Dorado County)	L	[b]	[b]	11
GDPUD Diversion from American River	M	[b]	8	6
Groundwater/Conjunctive Use				
New Wells (Redding, Butte, and Colusa Basins)	H	[b]	[b]	[b]
Big Valley Conjunctive Use	H	30	—	[c]
Other Local Options				
New Surface Water Diversion from Sacramento River and Cache Creek by YCFC&WCD	M	[b]	95	95
New Surface Water Diversion from Sacramento River by cities of Benicia, Fairfield, and Vacaville	M	[b]	8	8

[a] All or parts of the amounts shown for highlighted options have been included in Table 8-6.
[b] Data not available to quantify.
[c] Less than 1 taf.

supplies are needed primarily for drought year shortages. However, Yuba River onstream storage at the Parks Bar site or offstream storage at Waldo Reservoir are promising options. Parks Bar in particular could reduce the flood threat to the Yuba City-Marysville area and downstream levee systems on the Feather and Sacramento Rivers. Parks Bar could provide a drought year yield of 160 taf. Likewise, a 2.3 maf Auburn Dam would provide the Sacramento metropolitan area with substantial flood protection as well as augment the region's average year and drought year supplies by 85 taf and 51 taf, respectively. If options shown in Table 8-6 are implemented, average water year needs of the region would be fully met, although a drought year shortage would remain.

TABLE 8-6

Options Likely to be Implemented by 2020 (taf)
Sacramento River Region

	Average	*Drought*
Applied Water Shortage	**85**	**989**
Options Likely to be Implemented by 2020		
Conservation	—	—
Modify Existing Reservoirs/Operations	—	—
New Reservoirs/Conveyance Facilities[a]	—	160
Groundwater/Conjunctive Use	—	—
Water Marketing	—	—
Recycling	—	—
Desalting	—	—
Other Local Options	—	—
Statewide Options	85	51
Expected Reapplication	—	56
Total Potential Gain[b]	**85**	**267**
Remaining Applied Water Shortage	**0**	**722**

[a] Average year yield of Parks Bar Reservoir has not been quantified.
[b] With construction of Parks Bar Reservoir, average water year needs of region would be exceeded, although there is a substantial drought year shortage. In average water years, the surplus water could be available for use in other regions.

FIGURE 8-3

San Joaquin River Hydrologic Region

San Joaquin River Hydrologic Region

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Description of the Area

The San Joaquin River Region is bordered on the east by the crest of the Sierra Nevada and on the west by the coastal mountains of the Diablo Range (Figure 8-3). It extends from the Delta and the Cosumnes River watershed to the San Joaquin River watershed near Fresno. All or portions of counties within the study area include Alameda, Alpine, Amador, Calaveras, Contra Costa, El Dorado, Fresno, Madera, Mariposa, Merced, Sacramento, San Benito, San Joaquin, Stanislaus, and Tuolumne.

Summer temperatures are usually hot in the valley, and slightly cooler in the Delta and upland areas. In the winter, temperatures are usually moderate in the valley and cool in the Delta and upland areas. Annual precipitation on the valley floor ranges from about 17 inches in the north to 9 inches in the south.

TABLE 8-7

Population and Crop Acreage

	Population (thousands)	*Irrigated Crop Acreage (thousands of acres)*
1995	1,592	2,005
2020	3,025	1,935

The principal population centers are the Cities of Lodi, Stockton, Tracy, Modesto, Turlock, Merced, and Madera. The northwest part of the area, including Tracy and surrounding communities, is experiencing rapid growth as workers in the San Francisco Bay area accept the longer commute from the valley in exchange for the affordable housing. Table 8-7 shows the 1995 and 2020 population and crop acreage for the region.

TABLE 8-8

San Joaquin River Region Water Budget (taf)[a]

	1995		*2020*	
	Average	*Drought*	*Average*	*Drought*
Water Use				
Urban	574	583	954	970
Agricultural	7,027	7,244	6,450	6,719
Environmental	3,396	1,904	3,411	1,919
Total	**10,996**	**9,731**	**10,815**	**9,609**
Supplies				
Surface Water	8,562	6,043	8,458	5,986
Groundwater	2,195	2,900	2,295	2,912
Recycled and Desalted	0	0	0	0
Total	**10,757**	**8,943**	**10,753**	**8,898**
Shortage	**239**	**788**	**63**	**711**

[a] Water use/supply totals and shortages may not sum due to rounding.

Flood protection in the Cosumnes River floodplain has historically been provided only by privately-owned levees. As shown here, rural residential development in the floodplain has relied on this limited protection.

Irrigated crop acreage in the area is forecasted to decrease, primarily due to urban development on agricultural lands. The primary crops are alfalfa, corn, cotton, deciduous fruit and nuts, grain, grapes, and pasture. Major employers include agriculture, food processing, and service sector businesses.

The area has many wildlife refuge and wetland areas. The Grasslands area, in western Merced County, is the largest contiguous block of wetlands in the Central Valley and is an important wintering ground for migratory waterfowl and shorebirds on the Pacific Flyway. Wetlands and wildlife areas include managed wetlands on Delta islands, Grassland Resource Conservation District, Los Banos Wildlife Area, Merced National Wildlife Refuge, North Grasslands Wildlife Area, San Luis National Wildlife Refuge, and Volta Wildlife Area. (In 1996, Kesterson National Wildlife Refuge and San Luis National Wildlife Refuge merged, with the combined refuge keeping the San Luis name.) Of the total wetlands in the region, about 40,700 acres are privately owned.

San Francisco's Hetch Hetchy Reservoir in Yosemite National Park. The reservoir is impounded by O'Shaughnessy Dam.

Water Demands and Supplies

Table 8-8 summarizes the region's water demands and supplies. Significant 1995-level and 2020-level water shortages occur in both average and drought years.

Surface Water

Much of the valley floor area receives its water supply from Sierra Nevada reservoirs. Some Sierra Nevada facilities—such as San Francisco's system and EBMUD's system—export water from the region to serve communities in the San Francisco Bay Region. Agricultural lands west of the San Joaquin Valley trough are mostly served by the CVP. Agricultural lands in the northwest corner of the region receive their water supply by direct diversion from Delta waterways. In the foothill and mountain areas, water is either diverted directly from streams and lakes or from local storage reservoirs and conveyance facilities.

In north to south order, the major Sierra Nevada rivers draining to the valley floor in this region are the Cosumnes, Mokelumne, Calaveras, Stanislaus, Tuolumne, Merced, Chowchilla, Fresno, and San Joaquin Rivers. The San Joaquin River, which forms the southerly boundary of the region, flows westward out of the mountains then turns north and flows in the valley trough to the Delta.

The Cosumnes River, one of the smaller Sierra Nevada rivers, is unique in that it has no significant reservoirs on its entire length, although it has local irrigation diversions. (USBR's Jenkinson Lake is located on Sly Park Creek, a tributary to the Cosumnes River.) Riparian lands along the lower river are managed as a nature preserve. Flood protection needs on the Cosumnes River were highlighted by the January 1997 floods, when numerous breaks in private levees on the valley floor caused widespread local flooding. As discussed in the following section, proposals for a managed floodway are under consideration.

The Mokelumne River system includes some hydroelectric power development in the upper watershed, but the major reservoirs are EBMUD's Camanche and Pardee Reservoirs, which develop water supply for urban communities in the San Francisco Bay Region. Woodbridge Diversion Dam on the Mokelumne River near Lodi diverts irrigation water from the river to Woodbridge Irrigation District.

The 317 taf New Hogan Reservoir, the only large reservoir on the Calaveras River, was constructed by the USACE to provide flood protection and water supply for the Stockton area. New Hogan maintains a flood control reservation of up to 165 taf. To the south of New Hogan on Littlejohns Creek, USACE constructed Farmington Reservoir to provide additional flood protection for the Stockton area. Stockton East Water District provides the City of Stockton with supply from New Hogan. As part of its New Melones water conveyance project, SEWD constructed facilities linking Farmington Reservoir on Littlejohns Creek to Goodwin Dam on the Stanislaus River.

The CVP's 2.4 maf New Melones Reservoir is the largest reservoir on the Stanislaus River. Up to 450 taf of New Melones' capacity is reserved for flood control storage. Upstream from New Melones are Beardsley Reservoir (98 taf) and Donnells Reservoir (64 taf), owned jointly by Oakdale Irrigation District and South San Joaquin Irrigation District. Downstream from New Melones are Tulloch Reservoir (67 taf) and Goodwin Reservoir (0.5 taf), also owned by OID and SSJID.

The 479 foot-high New Exchequer Dam is a rockfill dam.

SSJID also owns the nearby 35 taf Woodward Reservoir on Simmons Creek. By virtue of an agreement with USBR, OID and SSJID have the ability to store 200 taf in New Melones Reservoir. USBR has entered into contracts with SEWD and Central San Joaquin Water Conservation District for New Melones water supply. SEWD holds a contract for 75 taf/yr of interim supply from New Melones. CSJWCD has CVP contracts for 80 taf/yr, 31 taf of which is interim supply. (Interim supply in this context means supplies that are available until future in-basin demands require use of the water.) USBR must also use New Melones to meet SWRCB San Joaquin River salinity standards at Vernalis. As discussed in the following section, enactment of CVPIA and management of project water dedicated for environmental purposes have created conflicts in meeting the multiple needs that New Melones was intended to serve.

The Tuolumne River (largest of the San Joaquin River tributaries) was developed by three local agencies and the City and County of San Francisco, which constructed Hetch Hetchy Reservoir (360 taf), Lake Lloyd (268 taf) on Cherry Creek, and Lake Eleanor (26 taf) on Eleanor Creek. San Francisco also participated with Modesto and Turlock Irrigation Districts in the construction of New Don Pedro Reservoir. (The reservoir is owned by the irrigation districts, but San Francisco has a water storage agreement with them.) This 2 maf reservoir impounds supplies which are diverted into MID's and TID's canal systems at La Grange Dam. Each district has a small regulatory and offstream storage reservoir on its mainline canal downstream from La Grange—the 29 taf Modesto Reservoir and the 46 taf Turlock Lake. MID serves lands north of the Tuolumne River, and TID serves lands to the south of the river.

New Exchequer Dam impounds Merced ID's 1 maf Lake McClure, the only large water supply reservoir on the Merced River. Merced ID has two small dams downstream regulating flow into its canal system. In 1997, Mariposa Public Utility District completed a small water diversion project on the Merced River. The project included constructing 8 miles of 12-inch pipeline to convey Merced River water to the town of Mariposa and surrounding areas.

The Chowchilla and Fresno Rivers are small relative to their northern neighbors. Each river has only one significant water supply reservoir. Buchanan Dam on the Chowchilla River impounds the 150 taf Eastman Lake, and Hidden Dam on the Fresno River impounds the 90 taf Hensley Lake. Both dams were constructed by the USACE, but their operations were integrated with the CVP. Chowchilla Water District holds a water supply contract for Eastman Lake supply, while Hensley Lake supply is contracted to Madera Irrigation District.

USBR's Friant Dam on the San Joaquin River impounds the 521 taf Millerton Lake. Several hydropower reservoirs are located in the river's upper watershed above Friant; however, the only consumptive use of water associated with them is reservoir evaporation. Total system storage including Millerton Lake is 1.1 maf. CVP water released from Friant Dam is diverted into the Madera Canal to the north and the Friant-Kern Canal (to the Tulare Lake Hydrologic Region) to the south. Chowchilla and Madera Irrigation Districts are the largest CVP water contractors on the Madera Canal. Central California Irrigation District's Mendota Dam, located on the San Joaquin River at its confluence with Fresno Slough/North Fork Kings River, forms Mendota Pool, from which more than 20 agricultural water agencies divert their supplies. As mentioned in Chapter 3, CVP exchange contractors divert Delta-Mendota water from the pool to compensate for the impacts of Friant Dam construction on their prior rights to San Joaquin River water. CVP water delivered to the Mendota Pool from Tracy Pumping Plant is the source of supply for nearby USFWS national wildlife refuges.

CCID, USBR, and others have evaluated the possibility of replacing Mendota Dam with a new facility to improve the structure's operational capabilities. The original dam at this site was constructed in the 1880s by the Miller et Lux Corporation.

Surface water supplies for the part of this region west of the San Joaquin Valley trough are provided largely by the CVP, through the Delta-Mendota Canal and the San Luis Canal reach of the California Aqueduct. CVP contractors receiving DMC supplies in the northern part of the region are small agricultural water agencies. The City of Tracy, with a contract for 10 taf/yr, is the only urban CVP water user in the northern end. Oak Flat Water District is the only SWP contractor served from the California Aqueduct within this region, with a maximum contract entitlement of 5.7 taf. The California Aqueduct and DMC carry water from the Delta into San Luis Reservoir for storage and later delivery. San Luis Reservoir marks the beginning of the State-federal joint use San Luis Canal. Lands adjacent to the San Luis Canal downstream from the reservoir are part of the CVP's service area, and receive their water supply through contracts with USBR. San Luis Water District is one of the larger CVP contractors in this area, receiving its supplies through both the DMC and the SLC.

The northwest corner of this region, including the communities of Byron, Brentwood, and Thornton, receives much of its water supply via direct diversion of surface water from Delta waterways. Local water supply agencies include East Contra Costa Irrigation District and Byron-Bethany Irrigation District.

Groundwater

Groundwater is an important source of supply for the region. Many urban areas rely solely on groundwater for their supply. Groundwater overdraft occurs in much of the valley floor.

Looking upstream at the California Aqueduct (left side of photo) and the Delta-Mendota Canal (right side). Bethany Reservoir is in the upper left corner.

Local Water Resources Management Issues

Cosumnes River Flood Management

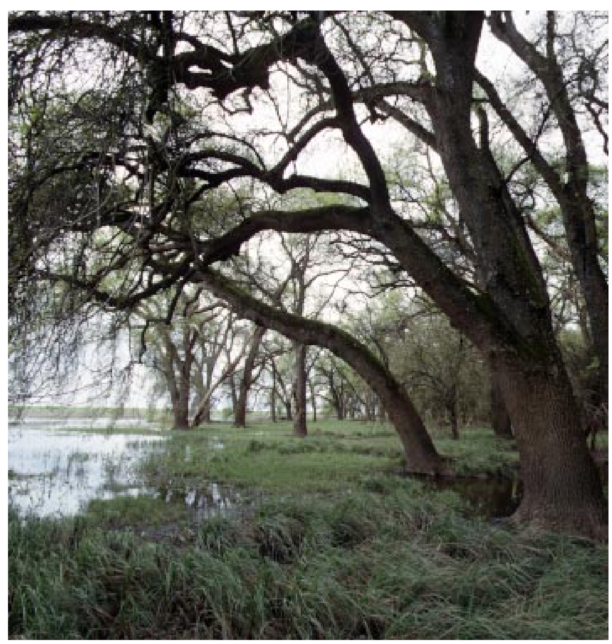
The Cosumnes River is unique among Sierra Nevada rivers for its lack of dams and related water development features. Efforts are ongoing to preserve and restore a riparian corridor along the river's path on the valley floor; the relationship of those efforts to recently emphasized floodplain management needs is being evaluated.

The Cosumnes River Preserve was established in 1987 to protect existing stands of valley oak riparian forest and to restore native habitat in flood-prone agricultural fields. The preserve, located between Sacramento and Stockton, is a cooperative effort of organizations including the Nature Conservancy, Ducks Unlimited, BLM, the Department, DFG, Wildlife Conservation Board, and Sacramento County.

The lack of upstream flood control on the Cosumnes River and the resulting periodic flooding have limited urban development in the lower watershed. Much of the agricultural land in the river's lower watershed is protected by private levees which experienced numerous breaks during the January 1997 floods. Nonstructural alternatives for flood control are being investigated, such as breaching levees and establishing levee setbacks to provide more area for flood waters to spread. Private lands have been identified for possible acquisition, subject to the willingness of sellers and the availability of funds.

Integrity of Delta Levees

Delta islands are protected by more than 1,000 miles of levees, and commonly lie 10 to 15 feet below sea level. Failure of these levees could occur as the result of earthquakes or floods, gradual deterioration, and/or improper maintenance. Composed largely of peat soils, many islands are vulnerable to seepage and subsidence. Subsidence of peat soils and settling of levee foundations increase the risk of levee failure.



Oak trees at the Cosumnes River Preserve.

EBMUD's Mokelumne River Aqueduct traverses the southern Delta.

The CALFED Bay-Delta Program identified the Delta levee system as an important resource. The program's strategy for improving its levee system integrity is to implement a Delta levee protection plan that would address levee maintenance, stabilization, subsidence reduction, emergency levee management, beneficial reuse of dredged material, and establishment of habitat corridors.

Interim South Delta Program and Temporary Barriers Project

In 1990, the Department, USBR and the South Delta Water Agency agreed to a draft settlement of a 1982 lawsuit by SDWA against the Department and USBR. The draft agreement focused on short-term and long-term actions to resolve agricultural water supply problems in the south Delta and included provisions to test and construct barrier facilities in certain south Delta channels. The testing program, referred to as the South Delta temporary barriers project, was initiated in 1991. Its objectives were short-term improvement of water conditions for the south Delta and the development of data for the design of permanent barriers. Long-term actions would be implemented through the Interim South Delta Program described in Chapter 6. ISDP's purpose is to improve water levels and circulation in south Delta channels for local agricultural diversions and to enhance the existing water delivery capability of the SWP through improved south Delta hydraulics. ISDP's preferred alternative would cost an estimated $54 million to construct and includes five components: constructing a new intake structure at Clifton Court Forebay; dredging a 4.9-mile reach of Old River; constructing flow control structures at Old River, Middle River, and Grant Line Canal; constructing an operable fish barrier at the head of Old River to benefit San Joaquin River salmon; and increasing diversions into Clifton Court Forebay to maximize pumping at Banks Pumping Plant.

Under the Department's temporary barriers program, small berms have been seasonally installed in the South Delta to improve channel water levels and water quality for Delta irrigators. A seasonal fishery barrier at the head of Old River is also installed as part of this program.

A draft EIR/EIS for ISDP was released in August 1996. The final EIR/EIS is scheduled for completion in late 1998. Meanwhile, installation and removal of temporary barriers in the south Delta continues. The number of temporary barriers installed and the installation schedule varies with hydrologic conditions and endangered species concerns.

San Joaquin County Groundwater Overdraft

Eastern San Joaquin County has a long history of declining groundwater levels. Groundwater extraction to meet agricultural and urban demands has created two pronounced pumping depressions since the late 1940s and early 1950s. The larger depression is between the Mokelumne River and the Stanislaus River. The center of this depression is east of Stockton, where groundwater levels can be more than 70 feet below sea level following the irrigation season. This pumping depression caused poorer water quality from the Delta to migrate toward the City of Stockton. Several municipal wells in west Stockton have been abandoned because of the decline in groundwater quality. The other groundwater depression is between the Cosumnes River and the Mokelumne River, extending north into Sacramento County. Groundwater levels here are more than 30 feet below sea level.

The Department recently completed a study of eastern San Joaquin County as part of a Stanislaus-Calaveras conjunctive use project. Data developed for this study suggested that the annual overdraft in the eastern San Joaquin County was about 70 taf, at a 1990 level of development. A later study completed by USBR as part of its American River water resources investigation estimated overdraft to be about 130 taf at a 2030 level of development. This study concluded that 77 taf/yr of additional supply would be needed to prevent migration of poor quality water into the Stockton area. Several overdraft management options are being considered, all of which require substituting surface water supplies for groundwater use. USBR proposed two major alternatives for providing future water supply—a conjunctive use alternative and a multipurpose Auburn Dam. In its 1998 record of decision for the study, USBR decided that it would not take further action to meet study area future water needs.

San Joaquin County filed a water rights application for an American River diversion of 322 taf in wet years via the Folsom South Canal. The existing canal would be extended, and would be used to provide supplemental supplies to reduce groundwater overdraft. San Joaquin County is also interested in participating in a conjunctive use project with EBMUD, in which EBMUD's American River CVP water would be stored in local groundwater basins prior to being diverted into the Mokelumne River Aqueduct. This approach was considered in EBMUD's 1995 water supply action plan described in the San Francisco Bay Region (Chapter 7), but was not included in EBMUD's draft EIR for conveyance of its CVP supply.

Penn Mine Remediation

Penn Mine is an abandoned copper/zinc mine first worked in the 1860s. Major activity at the site occurred in the early 1900s and during World War II. Mine stormwater runoff and acidic drainage historically entered the Mokelumne River near Campo Seco, above EBMUD's Camanche Reservoir, and caused fish kills in the river from the 1930s through the 1970s. EBMUD, in conjunction with DFG and the Central Valley RWQCB, made surface drainage improvements on the mine property and constructed Mine Run Dam in 1978 to provide storage and to control part of the mine runoff. EBMUD and the RWQCB began onsite neutralization and treatment of acid mine drainage in 1993. Litigation against EBMUD and the RWQCB by environmental organizations led to a negotiated agreement for long-term site remediation. An EIR/EIS completed in 1997 calls for excavation and removal of mine waste materials at the site, removal of Mine Run Dam, further site regrading, and revegetation.

Conservation Storage in Farmington Reservoir

USACE completed a reconnaissance study of Stockton metropolitan area flood control needs in 1997, in cooperation with the City of Stockton, San Joaquin County, and Stockton East Water District. The study evaluated modifying Farmington Reservoir to provide carryover storage. USACE also completed a conjunctive use study in 1997, evaluating Farmington Reservoir's potential to reduce groundwater overdraft in eastern San Joaquin County. Three alternatives were evaluated, including reservoir reoperation to allow year-round diversions at Rock Creek, dam modification for seasonal water storage, and dam modification for long-term water storage. (SEWD operates a Rock Creek diversion structure downstream of Farmington Dam to convey CVP water from the Stanislaus River to its service area during the irrigation season.) USACE's study showed that reoperating Farmington for year-round diversions at Rock Creek and groundwater

Burrowing owls are ground-dwelling owls found in open grassland areas and around cultivated fields. Increasing urbanization in the San Joaquin Valley will reduce the habitat available for these owls.

recharge would be the best alternatives for improving management of available water supplies from Littlejohns Creek and the Stanislaus River. If additional Stanislaus River water supplies became available to SEWD through CVP water deliveries, flood control releases from New Melones, or water marketing, storage in Farmington Reservoir might enhance other water management actions. A USACE study prepared in the 1980s suggested that Farmington Reservoir could be enlarged by as much as 160 taf for conservation storage.

SEWD identified two other actions to augment surface supplies—more groundwater recharge and a short-term transfer of 30 taf from Oakdale Irrigation District and South San Joaquin Irrigation District. The districts are preparing an EIR to market up to 30 taf/yr of their surface supply for 10 years, using existing conveyance facilities.

New Melones Reservoir Water Supply and Operations

SEWD and CSJWCD began constructing facilities in 1991 to convey 155 taf of interim CVP contract supply from New Melones Reservoir to their service areas. Much of the imported water was to be used to reduce local groundwater overdraft. Because of changes in the operation of New Melones Reservoir, little interim CVP water has been delivered to the two districts.

Enactment of CVPIA and the issuance of SWRCB Order WR 95-6, increased project water requirements for environmental purposes. Table 8-9 shows the quantities of environmental supplies provided from New Melones releases.

As discussed in Chapter 2, allocation of responsibility for meeting SWRCB Order WR 95-6 flow requirements is now pending in a water rights hearing before the Board. One alternative for meeting San Joaquin River flow requirements is the Vernalis adaptive management plan, negotiated among the river's water users for sharing their responsibilities for actions such as providing spring pulse flows. USBR is presently analyzing how VAMP implementation would affect New Melones operations.

Additionally, USBR and USFWS plan to conduct an appraisal-level temperature control study for New Melones Reservoir, as called for in CVPIA. The study will identify structural or nonstructural alternatives to control water temperatures in the river downstream from the dam.

Urban Growth Pressures from San Francisco Bay Area

San Joaquin Valley communities within commuting distance of the San Francisco Bay area are experiencing rapid growth, as persons who work in the Bay Area are attracted by lower housing costs in the Valley. During the real estate boom of the late 1980s and early 1990s, there was considerable local concern over water supply availability for proposed new towns on the western edge of the valley. At least nine new communities had been proposed in southwestern San Joaquin County, an area where additional groundwater development is constrained by both quality and quantity of supply. Few of these communities were ultimately approved by local land use planning authorities. One proposed community, New Jerusalem, was initially approved, but an amendment to the county's general plan is being processed to remove the community from the plan. Mountain House is one of the few new towns actually being developed.

TABLE 8-9
New Melones Releases for CVPIA Environmental Purposes (taf)

Water Year[a]	*Dedicated Water*	*Supplemental Water*	*Total*
1993	140.9	0.0	140.9
1994	22.7	45.1	67.8
1995	146.3	4.2	150.5
1996	113.4	0.0	113.4
1997	79.9	50.0	129.9

[a] USBR's water year is from March through February.

East County Water Supply Study

The East County Water Management Association is an organization of eleven cities and local agencies in eastern Contra Costa County—Antioch, Brentwood, Pittsburg, Byron-Bethany ID, East Contra Costa ID, Contra Costa County WA, Contra Costa WD, Diablo WD, Delta Diablo Sanitation District, Contra Costa County Sanitation District No.19, and Ironhouse Sanitary District. In response to urban growth pressures, the association conducted a study to identify and evaluate potential water management strategies for meeting the east county's future water needs. The study identified a variety of potential supplies to meet future water demands through 2040 including in-county surface water, in-county groundwater, recycled water, water transfers from outside the county, conjunctive use, and water conservation.

Because the area has access to surface water supplies through CVP contracts and local diversions, study results indicated that in-county surface water supplies could meet future water demands in average years. Shortages would occur after 2010 in drought years. Current study area groundwater use is about 14.5 taf/yr. Some areas (such as Brentwood, Discovery Bay, Bethel Island, and Hotchkiss Tract) depend entirely on groundwater. Others (such as Pittsburg, Antioch, and DWD) use groundwater to supplement surface water supplies. Groundwater quality problems in the eastern county may limit future groundwater development.

The study evaluated three water supply scenarios:

- Maximized local pooling of surface water supplies. This concept would require negotiation of new agreements for long-term transfer of surplus water supplies from two agricultural districts (ECCID and BBID) to agencies serving urban areas, and changes to the place of use/purpose of use in existing water rights.
- Continued groundwater pumping with maximized local pooling of surface water supplies.
- Continued groundwater pumping with existing levels of local pooling of surface water supplies.

The second scenario ranked the highest among the three scenarios. Spot water transfers and short-term demand reduction would provide drought year supply for this scenario. Recommendations made in the study included:

- ECWMA should commission a comprehensive groundwater study of the east county area. The study should focus on groundwater quantity and quality, and interactions between surface water and groundwater supplies. An in-county conjunctive use program to manage drought year shortages should be evaluated.
- An aquifer storage and recovery program should be investigated in the Randall-Bold water treatment plant area, in the event that ECWMA member agencies are required to limit their Delta diversions at some times of the year.
- ECWMA members should construct dual water distribution systems to facilitate future use of recycled water in all water service areas within the east county.
- Interties between water treatment plant service areas increase reliability and flexibility during emergencies. The Cities of Pittsburg and Antioch, CCWD, and DWD should discuss potential intertie benefits associated with CCWD's reliability improvement project.

Los Banos Grandes Reservoir Studies

The Department has studied potential SWP offstream storage sites south of the Delta, as described in Chapter 6. These studies led to a December 1990 *Los Banos Grandes Facilities Feasibility Report*, which recommended construction of a 1.7 maf reservoir and associated facilities on Los Banos Creek in western Merced County. The Department has placed this project on hold pending a CALFED decision on Delta

Grasslands Bypass Project Drainage Fee System

The fee system has tiered charges based on percent exceedance of monthly and annual selenium loads. These load targets are in accordance with RWQCB waste discharge requirements for agricultural drain water. If load targets are exceeded by more than 20 percent in any given year, the project may be terminated at the discretion of the USBR. An interim review of project performance will be conducted after two years of operation.

Monthly Fees for Percent Exceedance (Dollars)

Year	*0.1 - 10%*	*10.1 - 15%*	*15.1 - 20%*	*20.1 - 25%*	*25+ %*
1	700	1,400	2,100	2,800	2,800
2	1,200	2,200	3,200	4,200	4,200
3	5,200	7,600	10,100	12,500	12,500
4	6,800	10,100	13,400	16,700	16,700
5	8,300	12,500	16,700	20,800	20,800

Annual Fees for Percent Exceedance (Dollars)

Year	*0.1 - 5%*	*5.1 - 10%*	*10.1 - 15%*	*15.1 - 20%*	*20+%*
1	25,000	50,000	75,000	100,000	100,000
2	44,000	79,000	115,000	150,000	150,000
3	63,000	92,000	121,000	150,000	150,000
4	81,000	121,000	160,000	200,000	200,000
5	100,000	150,000	200,000	250,000	250,000

improvements. The project could then be reevaluated in consideration of those improvements and of the needs and financial capabilities of SWP contractors.

Merced Area Conjunctive Use Study

In 1993, the City of Merced and Merced Irrigation District began a two-year water supply planning process for eastern Merced County through 2030. The goals of the study were to manage groundwater, provide a reliable water supply for cities, protect and enhance the economic base of the region, protect MID's water rights, and maintain consensus for the plan. The advisory committee selected a groundwater recharge option as the preferred alternative. The groundwater basin would be operated in combination with a surface water storage and conveyance system. Studies to determine groundwater recharge quantities and locations are currently underway.

Agricultural Drainage

Significant efforts have been made to manage saline drainage water in the region. Closure of San Luis Drain has made it essential for agricultural districts to manage irrigation applications as efficiently as possible onsite until a regional solution for drainage management and disposal is developed. Some agricultural water districts in the region discharge drainage water to the San Joaquin River. Much of the salt and selenium loading in the river originate from Grassland WD's canals and from two sloughs tributary to the river—Mud and Salt Sloughs.

***Grasslands Bypass Channel Project*.** Agricultural drainage from the Grasslands Basin historically discharged to natural channels that meandered through Grasslands Water District. Flows in these channels eventually reach the San Joaquin River via Mud and Salt Sloughs. In an attempt to manage selenium loads entering the San Joaquin River, USBR is operating a 5-year Grasslands bypass demonstration project. A two-mile long channel was constructed to intercept drainage water that would otherwise flow towards Grasslands Water District. The new channel carries drainage water to the existing San Luis Drain, allowing the drainage water to discharge to the San Joaquin River. An agreement for reopening part of the San Luis Drain was signed by USBR and the San Luis and Delta-Mendota Water Authority. The agreement established a drainage incentive fee system to provide monetary incentives for reducing selenium loads discharged to the drain (see sidebar). The project became operational in 1996 and has significantly reduced salt and selenium loads entering Grasslands Water District and Salt Slough.

San Joaquin River Real Time Drainage Monitoring Program. Participants in the San Joaquin River Management Program set up a network of telemetered flow and salinity monitoring stations on the San Joaquin River. Data from the stations were linked to a flow model of the San Joaquin River and its tributaries. Information from the model was distributed to water managers by e-mail. A demonstration of the real-time monitoring effort was carried out in 1996. Grasslands Water District managers were informed that the model predicted a major increase in river flow. The district discharged a significant amount of high salinity water from its waterfowl ponds by partially draining them during the high flow event. This timed discharge resulted in better quality water in the San Joaquin River later that spring. A significant portion of the salt load from Grasslands had already passed through the system by the time agricultural diversions began. In 1997, CALFED approved Category III funding to implement a 2-year program to expand the monitoring network. The program is scheduled to begin in fall 1998.

Enlargement of Friant Dam

At 520 taf, Millerton Lake has a small storage capacity relative to the San Joaquin River's average annual flow. Enlargement of Friant Dam has been considered in the past to augment regional water supplies. Recently, needs for fishery flows and improved management of winter/spring floodwaters have been emphasized. USBR evaluated the potential yield of raising Friant Dam about 140 feet in the 1980s. The Resources Agency's 1995 SJRMP Plan recommended that enlarging Friant be studied for multipurpose use. Assembly Joint Resolution 7 in 1997 urged the federal government to promptly evaluate raising Friant Dam. Raising Friant Dam would provide water supplies for CVP water users and downstream riparian diverters, for SWRCB salinity and fishery flow requirements at Vernalis, and for dilution of agricultural drainage flows discharged to the river. These supplies would be obtained by storing surplus winter floodwaters, increasing flood protection levels for lands downstream. An issue that would need to be addressed is instream flows in the river immediately downstream from the dam, as described below.

Instream Flow Requirements Below Friant Dam

In 1988, the Natural Resources Defense Council filed a suit in U.S. District Court, seeking an injunction and declaratory judgment to prevent USBR from renewing long-term CVP water supply contracts without preparing environmental documentation and to require releases for instream uses from Friant Dam, based on Fish and Game Code Section 5937 and the public trust doctrine. The legal issues were:

- Does federal law require USBR to renew the water contracts subject to NEPA and ESA review?
- Does Fish and Game Code Section 5937 apply to federal projects?
- Has CVPIA preempted Fish and Game Code Section 5937?

The court found that CVPIA's passage had not caused the NEPA and ESA claims to be moot, nor had CVPIA preempted the plaintiff's claim under the Fish and Game Code. The court also ruled that USBR failed to comply with Section 7 of the ESA when it renewed contracts without consulting with federal wildlife regulatory agencies. The court declared all contracts renewed before CVPIA enactment invalid. The case was appealed to the Ninth Circuit Court of Appeals which upheld the District Court's ruling.

In a setting apart from the litigation, the Friant Water Users Authority, Natural Resources Defense Council, and Pacific Coast Federation of Fishermen's Associations have agreed to pursue mutually acceptable restoration activities on the San Joaquin River. Initially, the group has agreed to work on riparian habitat restoration along a 150-mile reach of the river from Friant Dam to the Merced River confluence. The objectives of the effort are to implement a plan for restoring a continuous riparian corridor in the study reach and to construct riparian habitat restoration projects.

Environmental Restoration Activities in the San Joaquin River Basin

Many restoration actions are being evaluated for the San Joaquin River system. Examples of completed actions include:

- A spawning gravel restoration project on the lower Stanislaus River was completed in 1996. This project consisted of constructing riffles and placing gravel for salmon spawning habitat at three sites, river miles 47.4, 50.4, and 50.9.
- A spawning gravel restoration project below Crocker-Huffman Dam on the Merced River was completed in 1990 and repaired in 1996.
- The Magneson Pond isolation project on the Merced River, completed in 1996, consisted of iso-

lating a gravel pit from the river and replacing spawning gravel.
- The M. J. Ruddy spawning gravel project was completed in 1993 on the Tuolumne River. Another project was completed in 1996 to construct channels above the M. J. Ruddy project, to equalize river flows to protect the spawning habitat from washout.
- The La Grange spawning riffle project, completed in 1994, consisted of constructing riffles and placing spawning gravel at three sites along the Tuolumne River.
- Funds from the SWP Four-Pumps Agreement have been used since 1994 to support one DFG warden assigned to enforce fishing regulations (reduce poaching of anadromous fish) on the San Joaquin River system.
- Temporary fish barriers have been constructed and removed on a seasonal basis every year at Hills Ferry on the San Joaquin River (downstream of the mouth of Merced River) and at the head of Old River in the Delta.
- Implementation of the CVPIA dedicated water provision and the Bay-Delta Accord have increased San Joaquin River instream flows. Spring pulse flows have also been provided.
- The 1996 Tuolumne River FERC settlement agreement among Turlock ID, Modesto ID, City and County of San Francisco, DFG, and others increased instream flows from New Don Pedro Reservoir, extended and supplemented fish monitoring requirements, and provided for non-flow fish habitat improvement measures.

Several programs are under way to provide additional fishery benefits in the region. Examples of ongoing fishery restoration projects include:
- The Category III program has contributed funding for a feasibility study of screening at Banta-Carbona Irrigation District's Main Lift Canal intake channel on the San Joaquin River.
- Plans for construction of Tuolumne Fish Hatchery are under way, although several environmental hurdles need to be addressed before a final decision is made to build the fish hatchery. Land for the hatchery was acquired by the Four-Pumps program in 1996.
- USBR is preparing plans to replace CCID's Mendota Dam. Replacement of the dam would improve fish passage and provide increased water supply to Mendota NWR.
- DFG and USFWS plan to restore the channel of a six-mile stretch of the Tuolumne River by isolating or filling gravel pits along the river and restoring spawning gravel habitat.

San Joaquin River Parkway Development

The San Joaquin River Conservancy is a State agency charged with acquiring and managing public lands within the San Joaquin River Parkway. The goal of the conservancy is to preserve and enhance the San Joaquin River's biological diversity, protect its cultural and natural resources, and provide educational and recreational opportunities to local communities.

The San Joaquin River Parkway includes the San Joaquin River and about 5,900 acres of land on both sides of the river, and extends about 22 miles from Friant Dam downstream to the Highway 99 crossing of the river. The parkway is planned as a riparian corridor with trails for hiking, horseback riding, and biking; boating access points; wildlife areas; and education areas. Approximately 1,900 acres are located in Madera County and 4,000 acres in Fresno County, of which approximately 1,600 acres are in public ownership. The conservancy, working with the Wildlife Conservation Board and the San Joaquin River Parkway and Conservation Trust, has been making land acquisitions for the parkway. Other completed projects include habitat restoration efforts and construction of 5 miles of a multiple-use recreation trail.

January 1997 San Joaquin River Region Flood Event

The January 1997 flood event was notable for its sustained rainfall intensity, the volume of floodwater, and the extent of the storm pattern—from the Oregon border down to the southern end of the Sierra. Over a three day period, warm moist winds from the southwest blew over the Sierra Nevada, pouring over 30 inches of rain on watersheds already saturated by one of the wettest Decembers on record. The volume of runoff exceeded the flood control capacity of New Don Pedro Reservoir and Millerton Lake. Although the peak flood release from New Don Pedro Dam was less than half the peak Tuolumne River inflow of 120,000 cfs, it was more than six times the downstream channel's flood control limit of 9,000 cfs. In all, thirty-six levee failures occurred along the San Joaquin River system, along with extensive damage related to high flows and inundation. Most of the damage occurred downstream of the Tuolumne River confluence.

The primary flood control issue facing the San Joaquin River Region is the lack of flood channel capacity. Channels and levees are generally designed for 50-year flood protection. Insufficient channel capacity is especially problematic in the lower San Joaquin River below the Merced River. At the lower end of the system, sediment deposition continues to raise the river bed and reduce channel capacity. Sediment deposition also promotes vegetation growth, thereby increasing channel roughness and further impeding flows. As urban development occurs on lands formerly used for agriculture, the need for higher levels of flood protection becomes more important.

The 1997 *Final Report of the Flood Emergency Action Team* to the Governor detailed several recommendations and possible actions for the San Joaquin River watershed, such as:

- A USACE reconnaissance study for the Tuolumne River to evaluate constructing a flood control impoundment on Dry Creek, restricting development in the floodplain, and developing offstream flood storage to be integrated with water supply storage.
- Acquisition of flood-prone lands (largely agricultural lands) in Stanislaus County which could be added to USFWS's San Joaquin National Wildlife Refuge. The lands would be managed to allow periodic flooding, and would provide temporary storage of flood peaks. A similar approach could be taken at the West Bear Creek Unit of the San Luis National Wildlife Refuge, where floodflows could be temporarily stored on existing refuge lands.
- Increasing the capacity of the lower San Joaquin River by measures such as channel dredging, setback levees, and improving bridge crossings.

Water Management Options for the San Joaquin River Region

Table 8-10 shows a list of options for the region, and the results of an initial screening of the options. The retained options were evaluated (Table 8A-2 in Appendix 8A) based on a set of fixed criteria discussed in Chapter 6.

Water Conservation

Urban. Urban water demand forecasts for 2020 assume that BMPs are in place; consequently, only those urban conservation efforts which exceed BMPs are considered as options. Urban water conservation options were deferred from detailed evaluation because they provide little cost-effective potential to create new water through depletion reductions.

Agricultural. The 2020 agricultural water demand forecasts assume that EWMPs are in place. As with the urban water management options, only those agricultural conservation efforts which exceed EWMPs are considered as options. Changes in irrigation management practices to attain SAEs of 76 to 80 percent would yield less than 1 taf/yr depletion reduction. Flexible water delivery, canal lining and piping, and tailwater recovery could each yield 2 taf/yr depletion reduction.

Modify Existing Reservoirs

Various agencies have looked at raising or modifying existing water supply and/or multipurpose reservoirs. USACE and SEWD are evaluating modifications or reoperation of Farmington Reservoir. Local runoff, plus New Melones or American River supplies, could be used to fill an enlarged reservoir.

New Reservoirs

Onstream Storage. Amador County Water Agency developed preliminary proposals for the Irish Hill and Volcano Reservoir projects. Irish Hill Reservoir, on Dry Creek, would serve areas near Ione with up to 23.7 taf of drought year supply. Volcano Reservoir, on Sutter Creek, would serve the communities of Sutter Creek and Amador City, in addition to providing flood control benefits for Sutter Creek. The estimated drought year supply would be 14.7 taf. Studies on both projects are inactive.

Amador County has participated in studies of the larger Middle Bar and Devils Nose reservoir projects. Alternatives for Middle Bar included a low and high dam, with drought year supplies of 12 taf and 159 taf, respectively. The larger Middle Bar Dam has been considered by EBMUD as a water supply option for its service area in the San Francisco Bay Region. The reservoir, however, could provide some local supply to Amador, Calaveras, and possibly San Joaquin Counties. A number of obstacles such as water rights, a FERC license, and financing would need to be addressed before proceeding with the project. The proposed Devils Nose project would be a hydroelectric power project with incidental water supply benefits, along the north fork and mainstem of the Mokelumne River. As con-

TABLE 8-10

San Joaquin River Region List of Water Management Options

Option	*Retain or Defer*	*Reason for Deferral*
Conservation		
Urban		
Outdoor Water Use to 0.8 ET_o	Defer	No significant depletion reductions attainable.
Indoor Water Use	Defer	No significant depletion reductions attainable.
Interior CII Water Use	Defer	No significant depletion reductions attainable.
Distribution System Losses	Defer	No significant depletion reductions attainable.
Agricultural		
Seasonal Application Efficiency Improvements	Defer	No significant depletion reductions attainable.
Flexible Water Delivery	Retain	
Canal Lining and Piping	Retain	
Tailwater Recovery	Retain	
Modify Existing Reservoirs/Operations		
Reoperate/Enlarge Farmington Reservoir	Retain	
New Reservoirs/Conveyance Facilities		
Montgomery Reservoir Offstream Storage (Merced County)	Retain	
Fine Gold Creek Offstream Storage (Madera County)	Retain	
Irish Hill Reservoir (Amador County)	Retain	
Volcano Reservoir (Amador County)	Defer	Geologic constraints.
Middle Bar Reservoir (Amador County)	Retain	
Devils Nose Reservoir (Amador County)	Retain	
Cape Cod Reservoir (Cosumnes River)	Defer	Major storage unlikely on Cosumnes River.
Bakers Ford Reservoir (Cosumnes River)	Defer	Major storage unlikely on Cosumnes River.
Mid-Valley Canal	Defer	Questionable water supply availability.
Groundwater/Conjunctive Use		
EBMUD/San Joaquin County Conjunctive Use	Defer	Under discussion; not yet defined.
Stockton East WD	Retain	
Madera Ranch	Retain	
Water Recycling		
Water recycling options	Defer	Water recycling options would not generate new water supply in this region.
Desalination		
Brackish Groundwater		
Agricultural Drainage	Defer	No present local agency plans.
Seawater		
—	—	—
Other Local Options		
—	—	—
Statewide Options		
—	—	See Chapter 6.

ceived, the project would include a 470-foot high dam at the Devils Nose site upstream from PG&E's Tiger Creek Forebay and below Salt Springs Reservoir. The reservoir would have a capacity of 145 taf. Water from the reservoir would be released via a 3-mile tunnel to a powerhouse with 41 mW of installed capacity. The proposed Devils Nose project was later merged with a proposed Cross County project, which included a conveyance system from Tiger Creek Afterbay to a 79 mW Cross County Powerhouse. Preliminary operation studies indicate a system yield of 23 to 30 taf/yr. EBMUD had also considered participation in the project. The project is currently dormant.

The Cosumnes River project was examined jointly by El Dorado, Sacramento, Amador, and San Joaquin Counties as a multipurpose project. The proposal included up to six reservoirs with hydroelectric power generation, flood control, and recreation to provide supplemental water supply benefits. Average year yield of the project was estimated at 170 taf. The project would include a 300 taf Cape Cod Reservoir and a 185 taf Bakers Ford Reservoir. The Cosumnes River is one of the few remaining undeveloped Sierra Nevada rivers. Interest in preserving the river's free-flowing characteristics and the difficulties associated with obtaining a FERC license would make large-scale water development on the river unlikely. Project planning is inactive.

Offstream Storage. USBR studied a 240 taf reservoir to store spills from Lake McClure. The proposed Montgomery Reservoir would be constructed on Dry Creek, north of the confluence of Merced River and Dry Creek, near the community of Snelling. Water would be conveyed by a two-way facility from Merced Falls Diversion Dam to Montgomery Reservoir. Releases would be used to improve instream flows and to maintain lower water temperatures for fall-run chinook salmon in the Merced River. Montgomery Reservoir would also provide additional flood protection in the San Joaquin River. About $3 million and three years would be required to complete the feasibility study and environmental review. The project, including the reservoir, conveyance, pumping, and appurtenant facilities has been estimated to cost about $135 million. The yield is estimated to be 35 taf during drought years. The drought year cost of this option is estimated to be $300/af. The project was recommended for further study in SJRMP's Plan.

In 1989, Madera Irrigation District asked USBR to investigate a 350 taf offstream storage project on Fine Gold Creek, a San Joaquin River tributary. Surplus flood flows would be pumped from Millerton Lake to the reservoir for water supply and power generation. Potential benefits also include fishery enhancements and flood protection. The average year yield is estimated to be 42 taf. According to MID's 1991 preliminary cost estimate, the project would cost in excess of $500 million. Project evaluation and investigation was estimated at $3 million, and at least 3 years would be required to complete feasibility and environmental investigations. The Fine Gold Creek project, although not originally formulated as such, is essentially an alternative to enlarging Friant Dam.

New Conveyance Facilities

Since the 1970s, several feasibility studies have been conducted on importing additional Delta supplies to reduce groundwater overdraft in the San Joaquin Valley. USBR's 1981 *A Report on the Mid-Valley Canal Feasibility Investigation* examined the possibility of constructing a canal that would supply portions of Madera, Merced, Fresno, Kings, Tulare, and Kern Counties with additional imported water.

The report suggested that water from the Delta could be conveyed to O'Neill Forebay using available capacity in the California Aqueduct. From O'Neill, a portion of the water would be delivered to Mendota Pool by an enlarged Delta-Mendota Canal, while the remainder would be conveyed to Kern County using available capacity in the California Aqueduct. To provide water to the rest of the service area, the proposal called for the construction of two branches of a new facility called the Mid-Valley Canal. The main branch would lift water from the Mendota Pool and carry it southeast to Fresno, Kings, and Tulare Counties. Madera and Merced Counties would receive their supply via a north branch, also diverting from Mendota Pool. Introduction of this additional water supply to the San Joaquin River Region could reduce groundwater overdraft and enhance wetlands, wildlife habitat, and recreation.

USBR initially identified a firm annual water supply in the Delta of approximately 500 taf available for export to the proposed service area. It was later determined that this supply was unavailable due to increased Delta outflow requirements and curtailment of proposed expansion of CVP facilities. Subsequent enactment of CVPIA and issuance of SWRCB Order WR 95-6 further limited available CVP water supply.

Groundwater Development or Conjunctive Use

Urban and agricultural water users have relied on both surface and groundwater supplies. Many local water purveyors use surface water allocations, purchased water, and excess flood water for groundwater recharge. Natural waterways, local agency canals, and State and federal conveyance facilities create opportunities for groundwater recharge, storage and conjunctive use programs.

EBMUD is continuing discussions with San Joaquin County interests for a joint groundwater storage/conjunctive use project. This option is part of EBMUD's water supply action plan described in Chapter 7; its yield is undefined at this time.

SEWD has proposed to construct a groundwater recharge facility at the northern terminus of the lower Farmington Canal. The canal would be extended about one-half mile, and a series of recharge basins constructed. The proposed facility could include up to 45 five-acre recharge basins, which could provide a combined recharge rate of 100 cfs. Estimated capital costs for the facility are about $14.25 million.

USBR and SLDMWA are investigating a proposed water banking project at Madera Ranch, southwest of the City of Madera. This storage facility would receive surplus water from the Delta for recharge. Water stored during wet years could be pumped in drought years for environmental, urban, and agricultural uses. The recharge pond area would be 3,500 acres and the potential storage capability is estimated to be about 390 taf. When available, flows in the Delta would be conveyed to Mendota Pool for diversion to the project at a rate of up to 400 cfs. Withdrawal capacity from the aquifer would be about 200 cfs, with average annual yield of about 70 taf at a cost of $226/af.

Phase I of the investigation, including geologic testing, and review of legal, financial, and environmental issues, was completed in April 1998. USBR recommends proceeding to Phase 2, pending discussions with the landowner. Two options would be examined in Phase 2. One would be a multi-year commitment to lease the facilities and services developed by the landowner. A second would be for USBR to purchase Madera Ranch property and develop a water banking facility.

Water Recycling

Most municipal and industrial water use in the San Joaquin River Region occurs on the east side of the San Joaquin Valley. Wastewater is generally spread for groundwater recharge. Wastewater that is directly or indirectly discharged to the San Joaquin River becomes available for downstream uses, including Delta outflow requirements. Because of extensive reapplication, no water recycling options within the basin qualify as new sources of supply from a regional viewpoint.

Several small water recycling projects serve local water management or wastewater disposal needs. Recycled water is currently used for golf course or pasture irrigation. The City of Stockton proposes to use recycled water for irrigation, groundwater storage, or transfer to possible future storage reservoirs such as a modified Farmington Reservoir.

Desalting

Many studies have explored saline groundwater desalting on the west side of the San Joaquin Valley. The Department has been involved in three such studies: a wastewater treatment evaluation facility in Firebaugh, a Los Banos demonstration desalting facility, and an Adams Avenue agricultural drainage research center. These studies indicated that production costs for treating agricultural drainage water were about $1,000/af. As discussed in Chapter 5, desalting costs are directly related to feedwater salinity. Today's costs for brackish groundwater treatment are in the range of $500 to $1,000/af, depending on feedwater salinity and the level of infrastructure already in place. Table 8-11 compares the salinity of various water sources.

The approximately 30 taf/yr of agricultural drainage water now collected for the Grasslands Bypass Project represents a source of brackish water available for treatment. Technology is available to treat the water, which would present a new supply to the region (as well as a means to improve San Joaquin River quality). For such a project to be feasible, a brine disposal solution would have to be found, as well as project participants. No such arrangements are currently under negotiation.

Statewide Options

Statewide water supply augmentation options are discussed and quantified in Chapter 6.

Options Likely to be Implemented in the San Joaquin River Region

Water supplies are not available to meet all of the region's 2020 water demands in average or drought years. Applied water shortages are forecasted to be

TABLE 8-11

Comparison of Salinity of Water Sources

Water Source	***Representative Weight of Solids in 1 Acre-foot of Water***
Mono Lake	110 tons
Salton Sea	60 tons
Seawater	48 tons
Brackish Groundwater (3,000 mg/L TDS)	4 tons
Colorado River at Parker Dam	1 ton
California Aqueduct at Banks Pumping Plant	500 pounds

63 taf and 711 taf in average and drought years, respectively. Ranking of retained water management options for the San Joaquin River Region is summarized in Table 8-12. Table 8-13 summarizes options that can likely be implemented by 2020 to relieve the shortages.

Reoperating Farmington Reservoir in conjunction with SEWD's plans for conjunctive use could augment supplies by 22 taf in average years and 8 taf in drought years.

Constructing Montgomery Reservoir could augment local drought year supplies by about 35 taf. As a statewide option, enlarging Friant Dam could provide 39 taf of additional average year supply for the region.

TABLE 8-12

Options Ranking for San Joaquin River Region

Option[a]	*Rank*	*Cost ($/af)*	*Potential Gain (taf)*	
			Average	*Drought*
Conservation				
Agricultural				
Flexible Water Delivery	L	1,000	2	2
Canal Lining and Piping	L	1,200	2	2
Tailwater Recovery	H	150	2	2
Modify Existing Reservoirs/Operations				
Reoperate Farmington Reservoir (surface supply only)	H	[b]	7	5
Enlarge Farmington Reservoir	M	350	17	8
New Reservoirs/Conveyance Facilities				
Montgomery Reservoir Offstream Storage	H	300	[b]	35
Fine Gold Creek Offstream Storage	M	[b]	42	[b]
Irish Hill Reservoir	L	430	33	24
Middle Bar Reservoir	L	[b]	—	159
Devils Nose Reservoir	L	[b]	[b]	25
Groundwater/Conjunctive Use				
Stockton East WD (includes reoperating Farmington)	H	100	22	8
Madera Ranch	M	230	—	70
Statewide Options				
See Chapter 6.				

[a] All or parts of the amounts shown for highlighted options have been included in Table 8-13.
[b] Data not available to quantify.

TABLE 8-13

Options Likely to be Implemented by 2020 (taf)
San Joaquin River Region

	Average	*Drought*
Applied Water Shortage	**63**	**711**
Options Likely to be Implemented by 2020		
Conservation	2	2
Modify Existing Reservoirs/Operations	—	—
New Reservoirs/Conveyance Facilities	—	35
Groundwater/Conjunctive Use	22	8
Water Marketing	—	—
Recycling	—	—
Desalting	—	—
Other Local Options	—	—
Statewide Options	39	—
Expected Reapplication	—	8
Total Potential Gain	**63**	**53**
Remaining Applied Water Shortage	**0**	**658**

FIGURE 8-4

Tulare Lake Hydrologic Region

Tulare Lake Hydrologic Region

. . .

Description of the Area

The Tulare Lake Region includes the southern half of the San Joaquin Valley and the uplands that surround it (Figure 8-4). The San Joaquin River watershed forms the northern boundary of the region, and the Tehachapi Mountains form the southern boundary. The region is bounded to the east by the Sierra Nevada crest and by the Temblor Range to the west. The climate in the valley varies from fog shrouded winters to long, hot summers. The valley typically receives about 6 to 11 inches of rainfall annually, while average precipitation in the mountains range from 12 to 36 inches, mostly in the form of snow. Most of the region's population is located on the east side of the valley. The area includes several rapidly growing cities, the largest of which are Fresno, Bakersfield, and Visalia. Other population centers include Hanford, Clovis, Tulare, Porterville, and Delano. Table 8-14 shows 1995 and 2020 populations and crop acreages.

The major employment sectors in Tulare Lake Region are based on agriculture, although the petroleum industry is important in parts of the valley's west side and in Kern County. In the sparsely populated areas on the west side of the valley, industrial water demands for petroleum recovery and production exceed municipal water demands. Most of the land area in the valley not devoted to urban and industrial purposes is used for agriculture. The predominant crop is cotton, followed by permanent orchards and vineyards. Major orchard crops are almonds and pistachios. Other major crops are alfalfa and pasture, grain, corn, and field and truck crops.

TABLE 8-14

Population and Crop Acreage

	Population (thousands)	*Irrigated Crop Acreage (thousands of acres)*
1995	1,738	3,127
2020	3,296	2,985

The Friant-Kern Canal extends southwards from Friant Dam, serving lands on the eastern side of the San Joaquin Valley. The canal is almost 152 miles long, and has a maximum capacity of 5,000 cfs.

This region receives runoff from four main river basins—the Kings, Kaweah, Tule, and Kern. The principal flood control and regulatory reservoirs for these rivers are Pine Flat Lake, Lake Kaweah, Success Lake,

The Buena Vista Aquatic Recreation Area, operated by Kern County, is located at the north end of the former Buena Vista Lakebed. The California Aqueduct (seen crossing the top of the photo, at the base of Elk Hills) skirts the lakebed's western edge.

and Isabella Lake. Major water conveyance facilities for the area include the California Aqueduct, the Friant-Kern Canal, and the Cross Valley Canal. Water districts within the region have developed an extensive network of canals, channels, and pipelines to deliver these water sources to users. Under normal conditions, the region has no natural outlet to the ocean. During high runoff years, excess water flows down the Kings River north fork channel toward Mendota Pool and on to the San Joaquin River. In the wettest years Kings River floodwaters reach the Tulare Lake via the south fork of the river. Excess runoff from the Kaweah and Tule Rivers also flows into Tulare Lakebed, flooding leveed agricultural fields.

The Tulare, Buena Vista, and Kern Lakebeds, once the region's drainage sinks, have been converted to agricultural use. Small areas in Buena Vista Lakebed are used for regulation of irrigation waters. Since 1977, excess snowmelt runoff from the Kern River has been transported to the California Aqueduct via the Kern River Intertie to alleviate flooding.

The region has several managed wetlands areas, including Pixley National Wildlife Refuge, Kern National Wildlife Refuge, and Mendota Wildlife Management Area.

Water Demands and Supplies

Table 8-15 shows regional water demands and supplies. Shortages at a 1995 level of development in average water year conditions represent the region's 820 taf of groundwater overdraft and 50 taf of shortages in Westlands Water District's service area.

Under 1995-level average hydrologic conditions, local surface supplies from the Kings, Kaweah, Tule, and Kern River systems are the most significant sources of surface water to the region. The next largest surface water source is the CVP, which delivers water through the joint State-federal San Luis Canal, Coalinga Canal, Friant-Kern Canal, and Cross Valley Canal. The other major source of surface water is the SWP.

The majority of the region's SWP supply is contracted to Kern County Water Agency. KCWA's SWP supply is distributed to fourteen of its member agencies; the largest entitlements go to Wheeler Ridge-Maricopa Water Storage District, Berrenda Mesa Water District, Belridge Water Storage District, and Lost Hills Water District. Since these four districts have limited (or no) groundwater supply, each relies almost entirely on SWP supplies to meet its water demands. Most other KCWA member agencies have Kern River, Friant-Kern Canal, Cross Valley Canal, or groundwater supplies available. Part of the City of Bakersfield's water supplies come from the SWP, via KCWA.

The Friant-Kern Canal conveys CVP supply to 24 long-term contractors in the region. Among the largest contractors for Friant-Kern supply are Arvin-Edison Water Storage District, Lower Tule River Irrigation District, and Delano-Earlimart Irrigation District. The San Luis Canal also distributes CVP supply, most of which goes to Westlands Water District. With an allocation of 1,150 taf/yr, Westlands Water District is CVP's largest contractor. Westlands supplies primarily agricultural users; however, about 5.5 taf/yr is supplied to urban users such as Lemoore Naval Air Station. (Even with a full CVP contract supply,

TABLE 8-15

Tulare Lake Region Water Budget (taf)[a]

	1995		2020	
	Average	*Drought*	*Average*	*Drought*
Water Use				
Urban	690	690	1,099	1,099
Agricultural	10,736	10,026	10,123	9,532
Environmental	1,672	809	1,676	813
Total	13,098	11,525	12,897	11,443
Supplies				
Surface Water	7,888	3,693	7,791	3,593
Groundwater	4,340	5,970	4,386	5,999
Recycled and Desalted	0	0	0	0
Total	12,228	9,663	12,177	9,592
Shortage	**870**	**1,862**	**720**	**1,851**

[a] Water use/supply totals and shortages may not sum due to rounding.

Westlands purchases about 200 taf/yr from other sources to meet its growers' normal crop needs.)

Arvin-Edison Water Storage District and KCWA entered into agreements in 1974 for participation in the Cross Valley Canal. AEWSD also entered into water exchange agreements with ten agencies in the Friant-Kern Canal service area. The exchange water is delivered through the California Aqueduct and the Cross Valley Canal to AEWSD facilities. AEWSD receives 128 taf annually of exchange water and makes available to exchange entities the first 174 taf of its Class I and Class II CVP entitlements from the Friant-Kern Canal.

Including overdraft, 2020 average year groundwater extraction is forecasted to be about 5.1 maf for the region. Since groundwater provides a buffer for fluctuating year-to-year surface supplies, its availability is of great importance to the region. Although urban use is expected to increase about 410 taf by 2020, groundwater overdraft is expected to decrease 150 taf (from 820 taf to 670 taf) within the planning horizon due to declining agricultural use. Most of the urban water use in the region is served from groundwater, although the Cities of Fresno and Clovis are taking actions to begin treating surface water supplies.

Local Water Resources Management Issues

Groundwater Overdraft

Annual fluctuations in groundwater levels vary with availability of surface water. About 70 percent of

The Kern River near Oildale, at the edge of the Sierra Nevada foothills.

The former Tulare Lakebed has been reclaimed for farming. Floodwaters from the Sierra now reach the lakebed only in the wettest years.

the region's overdraft occurs in the Kings-Kaweah-Tule Rivers planning subarea. Urban water demands in the subarea are met almost exclusively by groundwater. Agricultural development in the subarea includes 645,000 acres of permanent crops. Overdraft in the region is mitigated to a certain extent by planned recharge programs, over-irrigating crops in wet years, and allowing seepage from unlined canal systems.

Groundwater Banking Programs

The Department, in cooperation with KCWA and local water districts, began developing the Kern Water Bank conjunctive use program in 1985 as a component of the SWP. The proposed KWB program consisted of eight separate projects or elements. The Kern Fan Element was to be constructed on lands owned by the Department. Pursuant to the SWP's Monterey Amendment, the KFE was subsequently transferred to the Kern Water Bank Authority.

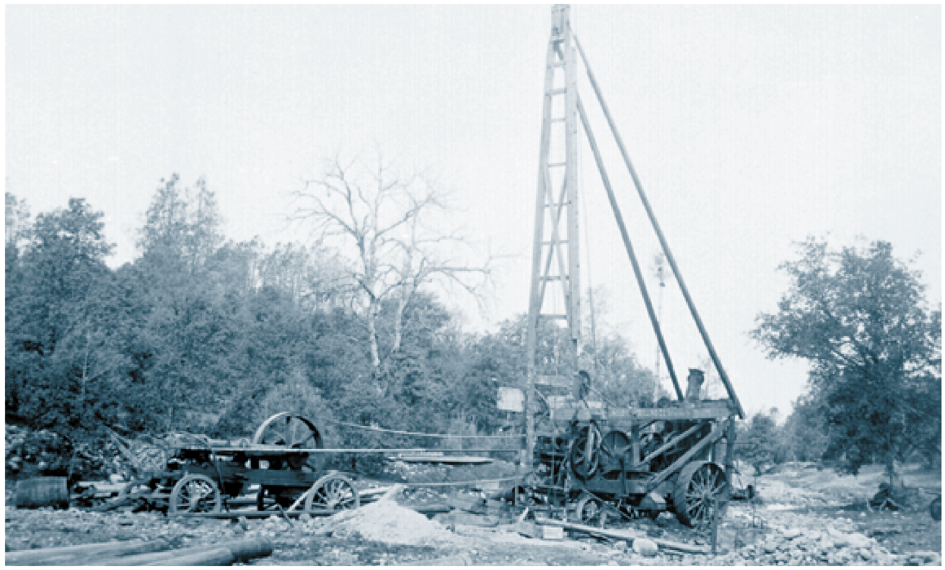
Semitropic Water Storage District is participating in an in lieu groundwater banking project with MWDSC, SCVWD, ACWD, and Z7WA. This project involves expanding SWSD's conveyance system, so that areas normally relying on groundwater will have surface water available in wet years. SWSD water users will receive excess surface water from its banking partners' SWP supply in wet years. In drier years, SWSD would release its SWP allocation to its partners and, if necessary, pump groundwater back into the California Aqueduct to meet its obligations. The maximum storage capacity of SWSD's groundwater basin is 1 maf. Commitments have been made for about 80 percent of the project. The remaining 200 taf of storage is available to other potential banking partners or for expansion of commitments by existing partners.

MWDSC and Arvin-Edison Water Storage District completed negotiations on a 350 taf water banking/exchange program. Water banked in this program would be provided by both AEWSD and MWDSC. AEWSD would provide up to 150 taf of its supplies to MWDSC, depending on the quantity of new water yield developed by the program. MWDSC would provide the remaining portion of the water supplies from its own sources. AEWSD will construct 500-600 acres of new infiltration basins, 15 new extraction wells, and a 4.5 mile pipeline intertie with the California Aqueduct.

Agricultural Drainage

Much of the Tulare Lake Region's agriculturally

California Aqueduct in foreground with the gates at the Kern River Intertie, which was constructed to allow Kern River floodwaters to enter the aqueduct. (In 1995, the intertie was operated in reverse under emergency conditions, to protect the aqueduct from overtopping due to upstream flood inflows.) The design flow for the intertie is 3,500 cfs.



Advances in well drilling technology were key to large-scale development of groundwater in the Central Valley. This photo show the state of technology circa 1914.

Courtesy of Water Resources Center Archives, University of California, Berkeley

rich westside must contend with high groundwater tables and drainage problems. Typically, applied irrigation water builds up above semi-impervious clay layers, creating a shallow, unconfined aquifer of generally poor to unusable quality. Efforts of the San Joaquin Valley Interagency Drainage Program to address westside drainage problems are described in Chapter 4.

Arroyo Pasajero and Other Westside Cross-Drainages

The Department, USBR, and USACE are completing a 5-year feasibility study to identify long-term solutions to flooding and sedimentation problems threatening the California Aqueduct at its crossing of Arroyo Pasajero. The SWP's problems at this uncontrolled ephemeral stream are similar to those being experienced by others in the area. Arroyo flows during the 1995 flood washed out a bridge on Interstate 5, resulting in the deaths of 7 motorists. Long-term solutions currently under consideration for the SWP include a substantial increase in floodwater and sediment storage. The Department is also investigating a similar problem 20 miles north of Arroyo Pasajero at the Cantua Creek stream group. These streams present similar flooding and sedimentation problems for the Aqueduct.

Kings River Fishery Restoration Actions

Kings River Conservation District and the Kings River Water Association are cooperating with USACE in a feasibility study of Kings River fishery habitat improvements associated with USACE's Pine Flat Dam. The study is evaluating impacts of original project construction, riparian habitat restoration downstream of the dam, potential operating strategies to minimize lake level fluctuations during spawning periods, and temperature control methods for trout populations. One component of the study includes a new multi-level intake structure for the reservoir, to better manage downstream river temperatures. USACE is also implementing a related project to install a bypass at the dam's powerplant so that releases can be made through the existing penstocks when the turbines are not in operation. This project will provide temperature control for the downstream trout fishery.

Water Management Options for the Tulare Lake Region

Table 8-16 shows a list of options for the region, and the results of an initial screening of the options. The retained options were evaluated (Table 8A-3 in Appendix 8A) based on a set of fixed criteria discussed in Chapter 6.

Water Conservation

Urban. Urban water demand forecasts for 2020 assume that BMPs are in place; consequently, only those urban conservation efforts which exceed BMPs are considered as options. Urban conservation options were deferred from evaluation because they provide little cost-effective potential to create new water through depletion reductions in the Tulare Lake Region.

TABLE 8-16

Tulare Lake Region List of Water Management Options

Option	*Retain or Defer*	*Reason for Deferral*
Conservation		
Urban		
Outdoor Water Use to 0.8 ET_o	Defer	No significant depletion reductions attainable.
Indoor Water Use	Defer	No significant depletion reductions attainable.
Interior CII Water Use	Defer	No significant depletion reductions attainable.
Distribution System Losses	Defer	No significant depletion reductions attainable.
Agricultural		
Seasonal Application Efficiency Improvements	Retain	
Flexible Water Delivery	Defer	Already highly developed; no significant depletion reductions attainable.
Canal Lining and Piping	Defer	No additional depletion reductions attainable.
Tailwater Recovery	Defer	No additional depletion reductions attainable.
Modify Existing Reservoirs/Operations		
Enlarge Pine Flat Dam	Retain	
Enlarge Lake Kaweah (Terminus Dam)	Retain	
Enlarge Success Lake	Defer	Being enlarged for flood control, not water supply.
New Reservoirs/Conveyance Facilities		
Rodgers Crossing Project	Defer	Segment of Kings River designated as a special management area, under the Wild and Scenic Rivers Act.
Mill Creek Reservoir	Defer	Cost too high.
Mid-Valley Canal	Defer	Questionable water supply availability.
Groundwater/Conjunctive Use		
City of Clovis Expansion of Recharge Facilities	Retain	
Kaweah River Delta Corridor Enhancement Recharge	Defer	Minimal yield.
Kern Water Bank Authority Recharge Facilities	Retain	
Buena Vista WSD Recharge	Retain	
Cawelo Water District Recharge	Retain	
Water Marketing		
SLDMWA Internal Reallocation of CVP Supply	Retain	
Water Recycling		
Water recycling options	Defer	Water recycling options would not generate new water supply.
Desalting		
Brackish Groundwater		
Agricultural Drainage	Defer	No present local agency plans.
Seawater		
—	—	—

TABLE 8-16

Tulare Lake Region List of Water Management Options (continued)

Option	*Retain or Defer*	*Reason for Deferral*
Other Local Options		
—	—	—
Statewide Options		
—	—	See Chapter 6.

Agricultural. The 2020 agricultural water demand forecasts assume that EWMPs are in place. As with the urban water management options, only those agricultural conservation efforts which exceed EWMPs are considered as options.

Improving irrigation scheduling would increase SAE to 76 percent, reducing depletions by 7 taf/yr. System improvements including pressure regulation and filtration and better irrigation scheduling would increase SAE to 78 percent and reduce depletions by 12 taf/yr. To reach 80 percent SAE, conversion to more efficient irrigation systems would be needed, reducing depletions by 17 taf/yr. Flexible water delivery is deferred because existing delivery systems in the region are highly developed, and further improvements would result in little depletion reduction at a high cost. Canal lining is deferred because areas in the region where lining and piping could reduce water depletions (the west side of the valley) already have such improvements. Tailwater recovery is not a significant future option because extensive tailwater recovery already occurs in the region.

Modifying Existing Reservoirs and New Reservoirs

Additional Storage in Kings River Basin. Pine Flat Dam, completed in 1954, is a USACE flood control project that also provides supplemental water supply to Kings River Basin water users. In 1974, the Kings River Conservation District commissioned a master plan to evaluate local solutions to flood control and water supply problems. This study identified three projects to improve storage and regulate Kings River flows. In order of cost-effectiveness, they were enlargement of Pine Flat Dam, Rodgers Crossing project, and Mill Creek project.

A 1989 USACE reconnaissance study investigated Kings River Basin flood control and water supply opportunities. After screening several alternatives, enlargement of Pine Flat Dam was retained for further study. A 15-foot increase of gross pool height appeared to have the best benefit/cost ratio. This alternative would increase the reservoir's storage capacity about 92.8 taf and provide an average of 12.7 taf/yr of

Flooding from Arroyo Pasajero spreads out as sheetflow over the lower portion of the Arroyo's alluvial fan. The Arroyo's periodic flooding closes State Highway 269 and threatens the integrity of the California Aqueduct.

Westlands Water District Distribution System

Westlands Water District is the CVP's largest water contractor. Among Central Valley agricultural water districts, WWD is unique both for its size (almost 1,000 square miles) and for its irrigation distribution system—which is based entirely on pipelines, rather than open canals. Altogether the distribution system has over 1,000 miles of buried pipe, varying in diameter from 10 to 96 inches. The basic design flow rate for each farm delivery system is 1 cfs per 80 acres.

additional average year yield. The major benefit would be flood control. The alternative was not economically feasible at the time. The Rodgers Crossing project, a proposed reservoir located upstream of Pine Flat Reservoir, was rendered infeasible when the damsite was included in a river segment subsequently designated as wild and scenic.

Mill Creek is a small, uncontrolled, intermittent stream tributary to the Kings River below Pine Flat Dam. The creek's 77,000 acre watershed produces an average annual runoff of approximately 30 taf. Heavy local rainstorm events occasionally result in flows in excess of 10,000 cfs, high enough to cause damage along the Kings River channel downstream. In the 1970s, USACE studied the feasibility of constructing a dam on Mill Creek, just upstream of its confluence with the Kings River. The benefits of such a project would include additional flood protection, water conservation, power generation, and recreation. The proposed reservoir would have a capacity in excess of 600 taf and would be directly linked with Pine Flat Reservoir by a tunnel, allowing the reservoirs to be operated conjunctively. In wet years, Kings River water that would flood agricultural lands in Tulare Lakebed could be diverted and stored in Mill Creek Reservoir. USACE's studies indicated that the project was not economically viable.

Additional Storage in Kaweah River Basin. Lake Kaweah is located on the Kaweah River about 20 miles east of Visalia. Terminus Dam, completed in 1962 by the USACE, provides flood protection and irrigation water supply to downstream users. A draft USACE feasibility report investigated continuing flood control problems and water resource needs on the Kaweah River and identified three alternative solutions—enlarge Terminus Dam, construct a flood detention dam on Dry Creek above Lake Kaweah, or construct a reservoir on Dry Creek with a connecting tunnel to Lake Kaweah. Upon further study, only Terminus enlargement was considered feasible due to environmental and cultural impacts of facilities on Dry Creek. Enlarging Terminus Dam would involve raising the spillway, increasing flood control storage by about 42 taf. On an average annual basis, the study estimates that in-basin irrigation water supply would increase by 8.4 taf through better regulation of flood flows. Congress authorized enlargement of Terminus Dam in the Water Resources Development Act of 1996. Construction is tentatively scheduled to begin in 2000 and to be completed in 2002. The Terminus Dam enlargement is projected to have a capital cost of about $37 million.

Additional Storage in Tule River Basin. In response to flood protection problems experienced during large storms, Tulare County and the Tule River Association requested USACE to consider providing additional storage in the basin by enlarging Success Lake. Success Lake is estimated to provide about a 55-year level of protection for the City of Porterville. A 1992 reconnaissance study found that a 10-foot increase in gross pool height with a corresponding increased storage capacity of 28 taf was the preferred alternative. The enlargement would provide a 100-year level of flood protection and increase irrigation water supply by 2.8 taf annually. USACE entered into a feasibility cost-sharing agreement with Lower Tule River ID for updating the 1992 study and for preparing an EIR/EIS. The draft feasibility study and EIR/EIS are scheduled to be released in 1998. Since the reservoir enlargement's primary purpose is flood control, the project is not considered further in this chapter as a water supply option.

New Conveyance Facilities

The Mid-Valley Canal and the constraints on its implementation were discussed in the San Joaquin River Hydrologic Region. The conveyance project is presently not feasible because it has no water supply.

Groundwater Development or Conjunctive Use

Many water districts and cities in the region use excess surface water allocations, purchased water, and floodwater for groundwater recharge. Local distribution systems and CVP and SWP conveyance facilities create opportunities for agencies to exchange and purchase surface supplies for groundwater recharge. Opportunities for groundwater recharge or conjunctive use projects are limited in some parts of the region, such as the west side of the valley, because of near-surface poor quality groundwater.

The City of Clovis has an agreement with Fresno Irrigation District entitling the city to an average of 14.9 taf of Kings River water and 1.1 taf of Class II water from Millerton Lake. Currently, the city's surface water supply is used exclusively for groundwater recharge. Existing facilities can recharge approximately 7.8 taf/yr. As the city expands into surrounding agricultural lands and acquires additional water supplies, average annual surface supplies are expected to increase to 30.1 taf by 2015. With this increase in supply, the city is developing new recharge sites to recharge an additional 3.5 taf/yr.

Visalia plans to develop new wells as its water needs grow, estimating that 15 additional wells will be necessary to meet average year water demands in 2020. Visalia is also working with the Kaweah Delta Water Conservation District and Tulare County on a Kaweah River Delta corridor study to investigate multiple use sites for groundwater recharge, floodwater management, and habitat restoration. The study is currently in the feasibility stage. The project would include recharge basins with a storage capacity of about 750 af. A demonstration project has been proposed to model integration of the multiple uses.

Pursuant to Monterey Agreement contract amendments and the transfer of the KFE, KWBA has been operating about 3,000 acres of recharge basins under an emergency CEQA exemption and an interim ESA Section 7 consultation, allowing the authority to recharge winter floodwaters. Since May 1995, KWBA has recharged about 700 taf on behalf of its member agencies. KWBA prepared a 75-year habitat conservation plan/natural community conservation plan covering the use of the 20,000-acre property. The HCP sets aside about 10,000 acres for habitat purposes. ESA listed species found in the project area include the kit fox, kangaroo rat, and blunt-nosed leopard lizard. KWBA plans to expand the recharge facility to 6,800 acres. The cost for this expansion, including additional conveyance structures, is about $30 million.

Buena Vista Water Storage District is planning to construct up to 200 acres of additional facilities to store excess Kern River water. The new facilities are estimated to cost about $250,000.

Cawelo Water District recently entered into an agreement with Texaco Inc. for water generated during oil recovery. A significant amount of water is trapped in oil bearing zones. The quality of much of this water is good, once it has been separated from the oil. The agreement negotiated by Texaco and CWD made possible the construction of an 8 mile pipeline to carry as much as 25 taf/yr of this water to the district. Additionally, Cawelo purchased almost 90 acres of land straddling Poso Creek in 1996. The district will allow the land to be flooded during high flows to enhance groundwater recharge. Work will begin shortly on a feasibility study to address the district's long-term plans for more recharge facilities.

Looking at the upstream face of Terminus Dam, with the outlet works structure in the background.

Water Marketing

As described in Chapter 6, the San Luis and Delta-Mendota Water Authority has negotiated an internal reallocation of its members' CVP supplies with USBR. Under this agreement, participating member agencies of SLDMWA may exchange wet year supplies for drought year supplies with SCVWD. Westlands Water District has initiated a short-term buy-back program for its water users who wish to sell their unused allocation or other supply to the district. The buy-back program would be implemented only if WWD had not finalized transfers from other sources to meet its total supplemental water needs. Marketing under this program would be intra-regional. WWD is also currently preparing a draft programmatic EIR on purchasing and transferring up to 200 taf/yr to its service area. Because details on proposed transfers are not yet available, this program is not included in the water management options evaluation.

Urban and agricultural development have reduced the habitat available to the San Joaquin Valley kit fox, a listed species.

Water Recycling and Desalting

In the Tulare Lake Region, most urban water use occurs on the east side of the San Joaquin Valley. Wastewater produced from urban use is generally recharged to groundwater basins where it reduces groundwater overdraft, or is extracted for other uses. No water recycling projects in the region qualify as new sources of supply from a regional perspective. As discussed in the San Joaquin River Region section, options for desalting agricultural drainage water were deferred for the Tulare Lake Region.

Statewide Options

Statewide water supply augmentation options are discussed and quantified in Chapter 6.

Options Likely to be Implemented in the Tulare Lake Region

Water supplies are not available to meet all of the region's 2020 water demands in average or drought years. Applied water shortages are forecasted to be 720 taf and 1,851 taf in average and drought years, respectively. Ranking of retained water management options for the Tulare Lake Region is summarized in Table 8-17. Table 8-18 summarizes options that can likely be implemented by 2020 to relieve the shortages.

Improvements in agricultural irrigation demand management will likely occur over the entire region, although much of the region is already efficient in its agricultural water management. Areas where further efficiency improvements will have the most effect will be where agricultural lands overlie shallow groundwater of poor quality. The west side of the valley will receive the most benefits from irrigation water conservation practices. These practices could reduce depletion annually by 17 taf if system upgrades are employed to increase SAEs to 80 percent.

The portion of the region's 2020 water shortage attributable to groundwater overdraft is estimated to be 670 taf. Several plans exist to expand recharge facilities or to construct new ones.

The region's local surface supplies have already been extensively developed and further development opportunities are limited. Modification of existing facilities through the enlargement of Lake Kaweah and Pine Flat Lake could produce about 21 taf/yr of additional yield for irrigation supply.

Water Marketing—WaterLink Program

In 1996, an electronic water marketing system went on-line in Westlands Water District. The WaterLink system was designed by the University of California Berkeley and Davis campuses, the Natural Heritage Institute, and farmers and water district staff. The project was funded by a grant from USBR. WaterLink allows district growers to use their home computers to post and read bids, access information on average prices and trading volumes, and negotiate transactions. WaterLink can also be used to schedule water deliveries and eventually to obtain water account balances, a feature that will enable water users to manage their water supplies more effectively. WaterLink is an intra-net system, available only to district growers, to allow them to make internal trades of in-district supplies.

TABLE 8-17

Options Ranking for Tulare Lake Region

Option[a]	*Rank*	*Cost ($/af)*	*Potential Gain (taf)*	
			Average	*Drought*
Conservation				
Agricultural				
Seasonal Application Efficiency Improvements (76%)	H	100	7	7
Seasonal Application Efficiency Improvements (78%)	M	250	12	12
Seasonal Application Efficiency Improvements (80%)	M	450	17	17
Modify Existing Reservoirs/Operations				
Enlarge Pine Flat Dam	H	470	13	[b]
Enlarge Lake Kaweah (Terminus Dam)	H	370	8	[b]
Groundwater/Conjunctive Use				
City of Clovis Expansion of Recharge Facilities	H	280	—	11
Kern Water Bank Authority Recharge Facilities	H	60	—	339
Buena Vista Water Storage District Recharge	H	75	—	29
Cawelo Water District Water Banking Project	H	50	—	13
Water Marketing				
SLDMWA internal reallocation of CVP supply	H	[b]	10	—
Statewide Options				
See Chapter 6.				

[a] All or parts of the amounts shown for highlighted options have been included in Table 8-18.
[b] Data not available to quantify.

TABLE 8-18

Options Likely to be Implemented by 2020 (taf)
Tulare Lake Region

	Average	*Drought*
Applied Water Shortage	**720**	**1,851**
Options Likely to be Implemented by 2020		
Conservation	17	17
Modify Existing Reservoirs/Operations	21	—
New Reservoirs/Conveyance Facilities	—	—
Groundwater/Conjunctive Use	—	392
Water Marketing	10	—
Recycling	—	—
Desalting	—	—
Other Local Options	—	—
Statewide Options	466	387
Expected Reapplication	4	187
Total Potential Gain	518	983
Remaining Applied Water Shortage	**202**	**868**